Compressed Air Magazine

Vol. 43, No. 9 London - New York - Paris September, 1938

FINAL STEPS IN PRODUCING RADIUM

Typical Rockwood Drive Performance

Use Rockwood drives for your compressors. They are low in first cost and will fit any make or any size of machine. They will increase your compressor capacities and often will save enough power to pay for themselves in a short time. Belt life may be doubled. Drive maintenance will be all but eliminated. Rockwood drives definitely will make your compressor more satisfactory to run.

A "hard drive" is this 150 hp barking drum in the new pulp mill of the Container Corp. at Fernandina, Florida. **The Rockwood flat belt drive** used is ideal for such service. Rockwood pivoted bases are equally successful with electric motors or with gas engines—with V-belt drives or with flat belts.

"The machines will do **more** and **better** work, and production will be more dependable. The cost to run will be **less** because we will save power, belts and maintenance."

ROCKWOOD PIVOTED MOTOR DRIVE

"The First Million H.P. is The *Toughest*"

The first million hp. transmitted by Rockwood Drives *was a tough million. Every* drive, it seemed, was a hard, trouble-making job. But that was what we wanted. That, we figured was the surest way to *prove* their worth. **And no drive ever won its way to success on a tougher proving ground.**

Typical is the barking drum drive pictured above. See how part of the motor weight, cradled in the belt, is used to first establish and then to maintain, the *minimum* belt tension required to handle the starting load without belt slip. Then as overloads occur (and they do occur in most hard drives) the electrical kickback of the motor adds additional tightness to the belt and gives additional transmitting capacity to the drive—to last only as long as the overload continues and then again to release. Because barking drums are tough drives, in this case quite a lot of the motor weight is used. But, *most important*—**at starting and for peak loads the belt tension automatically increases** and then reduces again as the load drops off to save belt wear and bearing friction losses.

The best way to know what Rockwood drives will do for you is to install one or more of your own. Then *you* can observe the *improvement in performance* of your driven machines, the *almost total absence of drive maintenance* and check the very real power savings. You can put in any number on free trial with responsibility for successful operation on our shoulders. *Write us today.*

ROCKWOOD MANUFACTURING CO., INDIANAPOLIS, IN

ON THE COVER

ALL the radium produced in the British Empire passes over the hot plate illustrated in the lower right-hand corner of the cover picture. It is in the refinery at Port Hope, Canada, where concentrated pitchblende ore from Great Bear Lake is processed. After a hundred or more chemical reactions, a joint barium-radium bromide is isolated. The radium is divorced from the union by repeated fractional crystallization. The photograph was taken by Photographic Arts, Toronto, and is reproduced through the courtesy of Canadian Industries, Limited.

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IN THIS ISSUE

IN THE major professional baseball leagues there are men who are known as ball players' ball players. By that is meant that they are not spectacular enough to be acclaimed by the public but are, nevertheless, appraised by their mates as sterling performers. Owing to their speed, gracefulness, and an innate sense of knowing in advance where the ball is going to be hit, they are able to make difficult fielding chances look easy. In the realm of mining, Gilbert LaBine is in some degree such a person. His discovery and development of the Great Bear Lake treasure trove constitute an epic of courage, foresight, and intelligence, but he acted with so little fanfare and pressagentry as to disguise the real magnitude of his feat. In our leading article we have endeavored to view his efforts in their true perspective.

•

ALTHOUGH the iron-founding industry has flourished since the invention of the cupola in 1722, the idea of accurately proportioning the charge of air in accordance with the charges of iron, coke, and limestone was not put in force until 1927. It is now generally recognized among foundrymen that this regulation of the air supply results in uniformly better castings and saves coke, power, and time. We present an article relating to the experiences of a Cincinnati foundry that has a modern cupola blower equipped with a constant air-weight regulator.

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WITH the sword-rattling of jingoists ringing in its ears, the world is justifiably fearful lest some excited zealot touch off another major war. Catastrophic consequences would inevitably result, and we can only voice the sincere hope that no fire reaches the tinder pile. If it does, compressed air will, willy-nilly, help wreak destruction. Some of the uses of air in naval warfare are outlined by Yates Stirling, Jr., Rear Admiral, U. S. Navy, Retired.

Compressed Air Magazine

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EDITORIAL CONTENTS

The Romance of Radium—*C. H. Vivian* 5683
How Air Aids our Battle Fleets—*Yates Stirling, Jr.* 5692
How Ancient Peoples Drilled Rock—*Herbert Manchester* 5695
Weighing the Air Blast Makes for Better Iron Castings—
Orville C. Hoover 5697
Boat Reaps and Destroys an Unusual Crop—*G. H. Dacy* 5699
Editorial—Concerning Radium 5701
The Foucault Pendulum 5702
Sound-Absorbing Telephone Booths for Factory Use 5703
Vermiculite Lends Color to World's Fair 5703
Picking the "Leviathan" Apart 5703
Ore Stained for Testing 5704
Flexible Coupling Maintains Tight Seal 5704
A 200-Year-Old Water Wheel 5704
Pneumatic Gauge for Strip Material 5705
Pressure Tank for Cleaning Rock Drills 5705
New Use for Calomel 5705
Industrial Notes 5706
New Bridge Across Kansas River 5706

ADVERTISING INDEX

Air-Maze Corporation 20
American Air Filter Co., Inc. 23
Bucyrus-Erie Company 21
Burgess Battery Co. 22
Combustion Engineering Co., Inc. 16
Compressed Air Magazine Co. 19
General Electric 14
Goodrich Company, The B. F. 12
Hercules Powder Co., Inc. 7
Ingersoll-Rand Co. ..... 6, 17, 24, 3d Cover
Industrial Clutch Company 15
Jarecki Manufacturing Co. 23
Jenkins Bros. 9
Maxim Silencer Co., The 25
National Forge & Ordnance Co. 20
Norton Company 10
New Jersey Meter Co. 22
Rockwood Mfg. Co. ..... 2d Cover
Schrader's Son, A. 23
Square D Company 25
Staynew Filter Corp. 3
Straight Line Foundry and Machine Corporation, The 25
Texas Company, The 4–5
Timken Roller Bearing Co., The. 8
Vogt Machine Co., Inc., Henry 18
Westinghouse Electric and Manufacturing Co. ..... 4th Cover
Willson Products, Inc. 20

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The Romance of Radium

C. H. Vivian

AS EVERY newspaper reader knows, Canada is now the richest source of man's most precious substance, radium. Thanks to the exploitation of an incredibly high-grade silver-uranium deposit at the edge of the Arctic Circle, the cost of the scientific wonder metal of the Curies has been cut by two-thirds; but, by comparison with other materials, its price remains sufficiently high to stir the imagination. Actually, despite the tremendous reductions that have taken place, it still requires 20,000 ounces of gold to buy one ounce of radium!

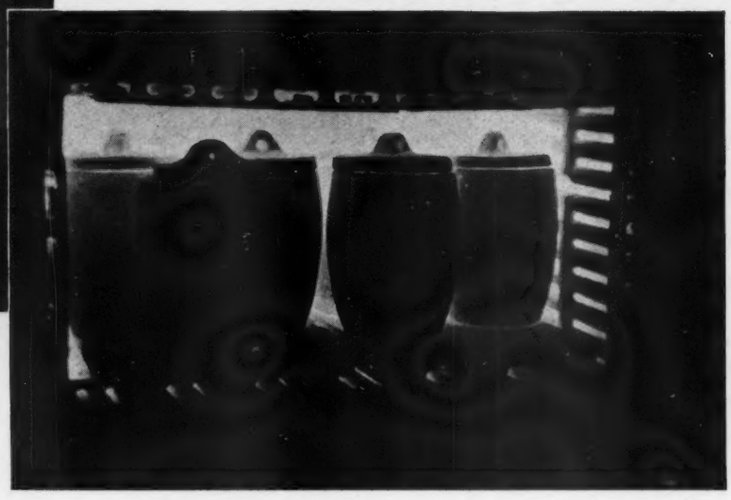
We often hear the lament that there are no more frontiers to be conquered and that romance has passed from the business and industrial horizon. Yet for stark interest, and as an example of virile man's conquest of relentless natural forces in the frozen Northland, few stories of fact or fiction, past or present, can match the saga of Eldorado Gold Mines, Limited. The tale is no longer a new one; but, as is the case with most truly great dramatic presentations, repetition can rob it of little of its spine-tingling thrill.

Canada's bountiful natural storehouse of radium could hardly have been uncovered in any age but this one. It needed winged transportation for its discovery, and has been even more dependent upon it for its successful development. It also needed the fire of human initiative and daring. But human nature does not change much, and in Gilbert LaBine, the Argonaut of Eldorado, there were combined all those splendid physical and mental endowments that have always enabled men of the higher stamp to triumph over Nature's severest obstacles.

The Eldorado Mine is located on LaBine Point, on the northeast shore of Great Bear Lake, Northwest Territories, just 28 miles south of the Arctic Circle. It is America's farthest-north mine. By air line it is 1,140 miles from Edmonton, Alta., and by water route it is 1,450 miles from the nearest railroad at Waterways 300 miles north of Edmonton. This water route, which follows the McKenzie River system, is shown on an accompanying map. Because 5 tons of chemicals are required to refine each ton of concentrated ore, it is cheaper to ship the concentrates out than it is to transport the chemicals to the mine. Accordingly, the refinery was built at Port Hope, Ont., 4,000 miles by water and rail from Great Bear Lake and not far from the Niagara peninsula where most of the necessary chemicals are produced.

Northwest Territories comprises more than one-third of all Canada and is ten times the area of the British Isles. Its northernmost sections are so remote from civilization that few prospectors could reach them until aerial transportation was available; and great expanses have yet to be traversed by white men. Nevertheless, the region experienced a brief but spirited mineral boom more than 350 years ago. During Queen Elizabeth's reign, navigators sought a shorter and safer route from England to Japan and China than the one Magellan had found. In 1576, when Martin Frobisher sailed into the bay in Baffin Island that now bears his name, he was sure that he had discovered a connecting passage between the Atlantic and Asiatic seas. When wind, ice, and other obstacles forced him to turn back, he took with him a piece of black rock that one of his officers had found. Upon his return, he gave it to the wife of one of the venturers or backers of his expedition. As recorded by Hakluyt: "She by chance threw it in the fire so long that at length, being taken forth and quenched in a little vinegar, it glistened with a bright marquesset of gold. Whereupon, the matter being called in some question, it was brought to certain goldfiners in London to make an assay thereof, who indeed found it to contain gold and that very richly for the quantity."

Visualizing great rewards, the venturers in 1577 financed a second expedition which numbered among its members fourteen miners and gold refiners. The party came back the same year with 200 tons of an-



Photos, courtesy Canadian Industries, Limited

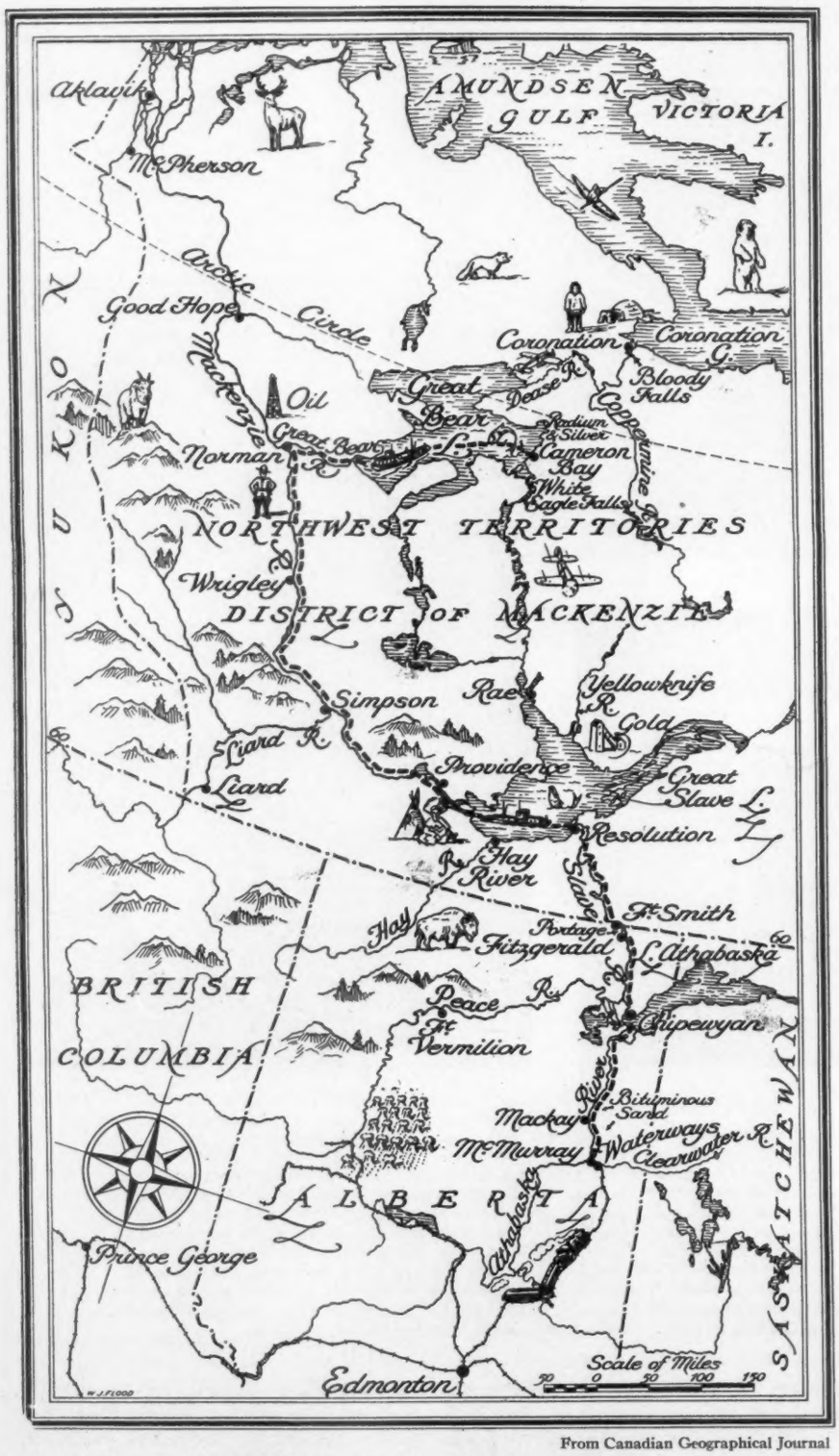
REFINING OPERATIONS

As received in bags at the refinery, the concentrates contain radium, uranium, silver, and many less valuable components which do not warrant recovering. After a preliminary roasting to drive off sulphur, the resultant dust is reroasted with common salt to form chlorides (top left). Uranium is the colorful element in the combination, and its journey from the steaming vats of olive-green liquor (center of pages) through the many steps produces salts of various brilliant hues. Sometimes they also strike a somber note, for when the red-hot pots of uranium oxide (just above) cool after being removed from the electric furnace, they contain a dull-black powder. In contrast with the uranium, the radium solutions are not attractive to the eye. The radium-barium carbonate (top of this page) resembles bubbling chocolate-colored batter as it is acidified with hydrobromic acid. Eventually, all the radium, ably chaperoned by its chemical twin, barium, reaches the fused silica vessels pictured at the extreme right, and from that stage on the two elements, both in the form of bromides, are wrested apart by fractional crystallization. The process culminates in the tiny crucibles shown on our cover. The final product is a white salt containing 9 parts of radium bromide to 1 part of barium bromide.

other mineral of which they claimed there were mountains to be had. Apparently, "additaments" were made—that is, the specimens were "salted," for the assayers' reports were favorable and the venturers, including Queen Elizabeth, gave money to build a smelter and refinery in England and to outfit a still larger expedition. After having received the queen's blessing, fifteen ships set forth in 1578 and returned after many mishaps with more than 1,000 tons of the mineral. It proved to be practically worthless, and the Company of Cathay, as the backers were known, was forced into liquidation. From that time on until the airplane gave access to the interior, the search for minerals in that desolate area was limited to sections close to rivers and lakes.

The first important discovery was the finding, in 1920, of the Norman oil field 100 miles south of the Arctic Circle and close to the McKenzie River. There being no local markets, it was held in check until 1932 when one well was uncapped and a small refinery built to supply fuel for the oil-driven boats and mining plants that were beginning to come into the North. The proximity of the oil field has proved to be of advantage to the Eldorado operations, as will be brought out subsequently.

During the long interval the Great Bear Lake deposits lay untouched, occasional explorers and trappers passed that way. In 1900, Dr. Mackintosh Bell headed a party that went into the region on behalf of the Geological Survey of Canada. One of the five members of the expedition was Charles Camsell, now Deputy Minister of Mines and Resources of the Dominion of Canada. In his official report written in 1901, Doctor Bell, in his reference to the area where Eldorado Mines is located, included the following passage: "In the greenstones east of McTavish Bay occur



From Canadian Geographical Journal

WATER ROUTE TO GREAT BEAR LAKE

From railhead at Fort McMurray to Cameron Bay is approximately 1,500 miles. The cost of freighting the first mining equipment to Eldorado in 1932 was $320 a ton. The rate has been steadily reduced until now it is $110 a ton, the latest drop having been effected when the mining company acquired control of the Northern Transportation Company. In the summer of 1937 two diesel-powered, pusher-type tugs, "Radium Queen" and "Radium King," were put in commission. They were built at Sorel, Que., then dismantled and shipped 3,000 miles to Waterways. There the "Radium Queen" was assembled and towed the sections of the "Radium King" 287 miles to Fitzgerald, from where they were hauled overland 16 miles to Fort Smith, assembled, and the vessel placed in service in the 820-mile stretch between that point and Fort Norman. The "Radium Queen" plies the upper waters, all freight having to be portaged between Fitzgerald and Fort Smith.

numerous interrupted stringers of calcspar containing chalcopyrite, and the steep, rocky shores which here present themselves to the lake are often stained with cobalt-bloom and copper-green."

It has been frequently written that this report inspired LaBine's fruitful prospecting trips into the area and that, having been at Cobalt, Ont., several years before, he knew that cobalt-bloom was an indication of the probable existence of silver. La Bine's own story, as told to the Canadian Institute of Mining and Metallurgy a few years ago, does not entirely corroborate this view, for he decided, in 1928, to go on an exploration trip to the Northwest Territories and did not obtain a copy of Doctor Bell's report until 1929, when he began making active plans for his first journey.

Eldorado Gold Mines, Limited, was formed in 1926 by LaBine and others to work a gold property in the Long Lake District of Manitoba. The venture was not entirely successful, and was discontinued in 1928. LaBine thereupon prevailed upon his associates to let him seek additional mineral deposits, and they acceded. It would seem then that he was hopeful of finding gold; and it is doubtful if the thought of radium ever entered his mind. "From my earliest prospecting days," La Bine explained, "I had overheard conversations among older men regarding interesting geological areas in that field (Northwest Territories), and I also contacted several people who claimed to have seen ore, or found ore. I even went so far as to arrange their transportation for the trip. However, I was disappointed, as none of them came with me and I went on alone."

LaBine's first move, in 1928, was to ask Leigh Brintnell, operating manager of Canadian Airways, to lay down caches of gasoline preparatory to making a flight the following year. Succeeding in this, he went ahead with his plans. He and Brintnell left in the summer of 1929 as soon as the ice was broken up on the northern rivers and lakes, flying to Fort Franklin, at the western end of Great Bear Lake, and thence over the north shore of the lake to what is now called Sloan River. Observing some huge quartz outcrops from the air, LaBine made up his mind to have a look at them, and arranged with Brintnell, who was going on to Dawson City, to come back for him in two weeks. Brintnell was unable to do this; but from Fort Simpson he sent another flier, C. H. Dickens, who met LaBine at Hunter Bay, Great Bear Lake, and took him back to Fort Simpson. *En route* La Bine noticed numerous gossan(iron-stained) hilltops while flying over the shore of McTavish Arm, and immediately decided to return there for a full season of investigations. With that in view, he made notes of their location. Fortunately, fellow directors in the Eldorado company approved this suggestion, and LaBine was given a free hand.

After having been disappointed by two men that he had expected to accompany

him in 1930, LaBine engaged E. C. St. Paul of Red Lake as his assistant. Having had a special canoe constructed, he arranged with his brother, Charles LaBine, to take this, together with a supply of tools and food, via the water route and to meet him at Hunter Bay when Great Bear Lake was free from ice. Meanwhile, Gilbert LaBine and St. Paul flew to the Camsell River area south of Great Bear Lake at the end of March. They carried with them a sectional canoe, sufficient food for the season, and two strips of steel to serve as sled runners. Despite temperatures of 20 to 45 degrees below zero Fahrenheit, they began examining the country with the idea of eliminating sections they considered unfavorable, all the while making their way toward McTavish Arm.

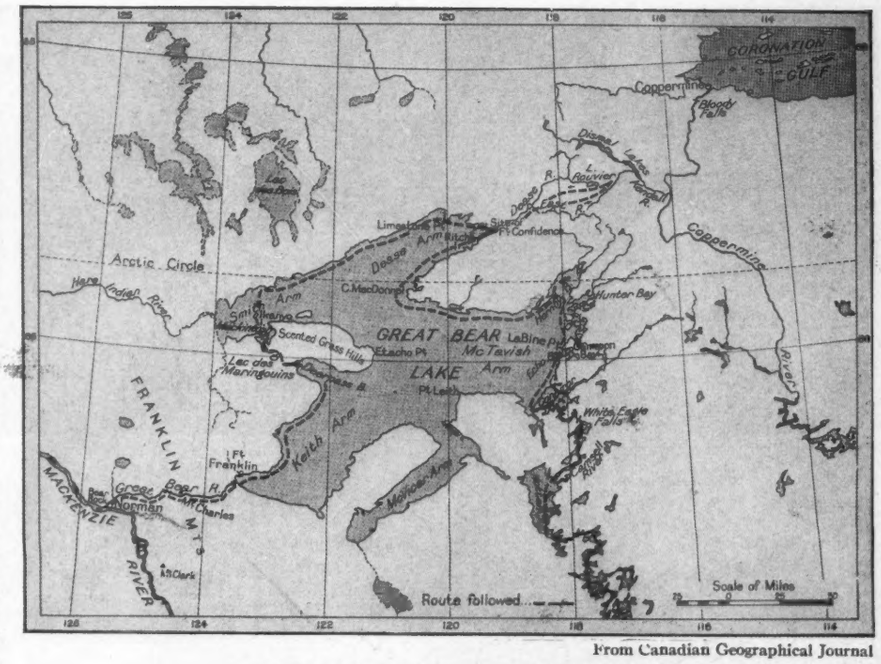
Drawing loads of 550 to 600 pounds each, often with great difficulty, the two men succeeded in reaching what is now LaBine Bay on May 15. Soon after they had established camp there, St. Paul went snowblind, so La Bine prospected alone. During this period he made his first strike of silver and cobalt minerals on a small island, afterward locating more cobalt along a cliff on the mainland. In following the latter outcroppings, he discovered pitchblende, the radium-bearing ore. Fortunately, LaBine had sufficient knowledge of mineralogy to know what it was, and further prospecting revealed a second vein of it.

Upon his return to camp, LaBine told St. Paul of the pitchblende finds but said nothing about his silver discoveries. The latter, in fact, were shown to no one until the following year, although two high-grade veins were covered by the claims staked. St. Paul having regained his sight, the two men moved northward to the Sloan River section, which LaBine had visited the year before, but were unsuccessful in locating additional pitchblende. Later in the summer they were joined by Charles LaBine, Shirley Cragg, and Leo Seaburg, and with the hand drills and explosives which they had brought were able to uncover extensions of the pitchblende deposits at LaBine Point.

Satisfied that they had made an important discovery, they sent some of the ore to the Mines Branch of the Canadian Government at Ottawa and suggested that an official investigation be conducted. As a result, Hugh Spence, government mineralogist, was sent into the field in 1931 and made a detailed examination and report that confirmed the beliefs of the prospectors.

Even though the value of the ores was unquestioned, the remoteness of the deposits caused many to doubt that a paying mine could be developed. There was another extenuating circumstance that contributed to this doubt, and that was the lack of information regarding the complex process of extracting radium from the ore. Inquiry disclosed that no assistance on this point could be hoped for from the Belgian interests that were then in control of the radium industry by virtue of their ownership of ore deposits in the Katanga district of the Congo.

Undaunted by these stumbling blocks, the company went ahead, with Gilbert La Bine the driving spirit; and within three years after the strike, the Port Hope refinery had been built and the first radium salts isolated. Since then the enterprise has grown rapidly, and it is now on a successful financial basis. In 1936 it showed a profit, before taking depletion and income tax into account, of $821,000. Meanwhile, the price of a gram of radium has been reduced from $75,000 to $25,000. All this was accomplished in the face of an almost endless



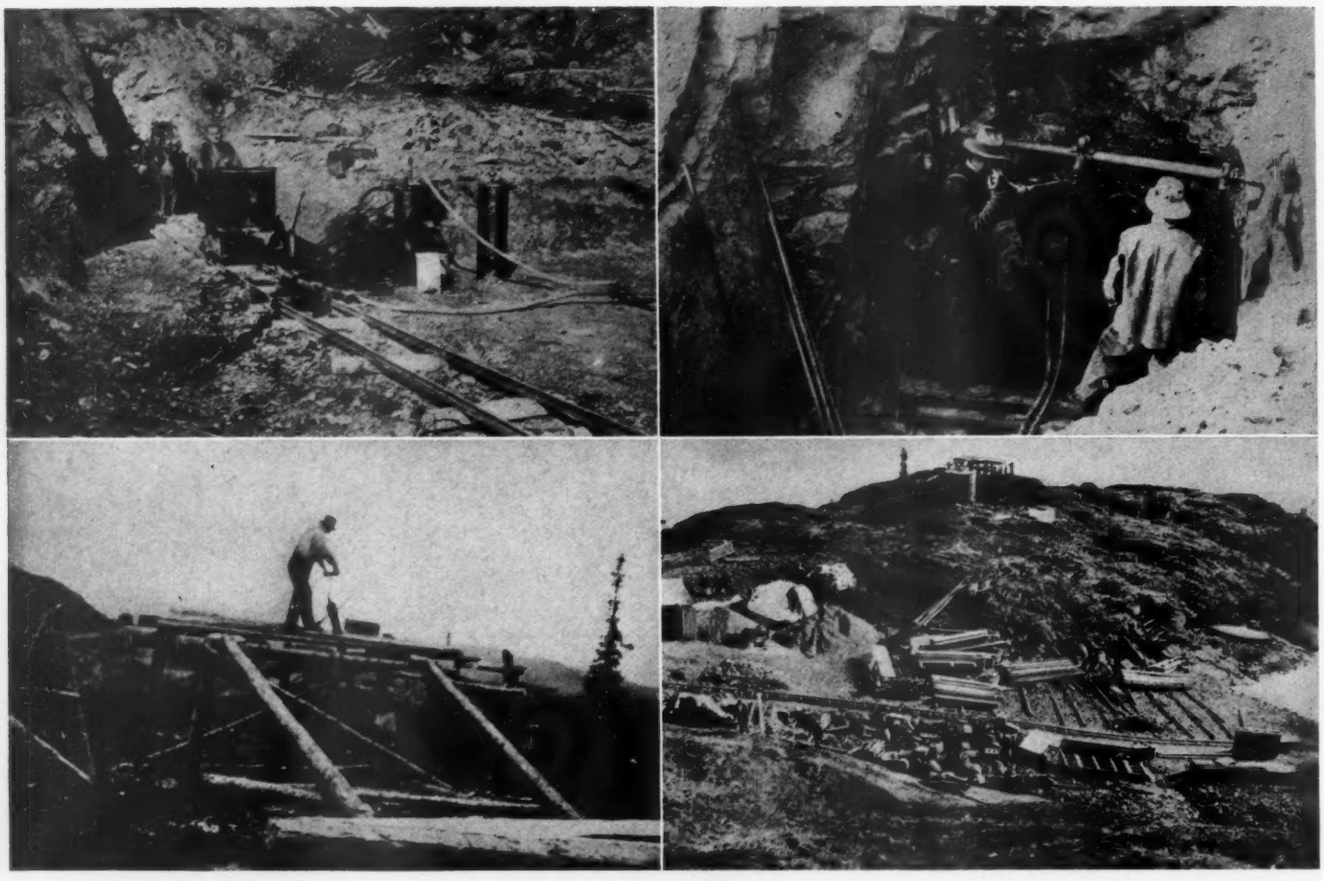
From Canadian Geographical Journal

ROUTE OF THE BELL EXPEDITION

The first authentic mention of mineralization at Great Bear Lake was contained in a report by Dr. Mackintosh Bell of the Geological Survey of Canada in 1901. The report covered an exploratory trip made in 1900. One of the five members of the party was Dr. Charles Camsell, now Deputy Minister of Mines and Resources for Canada, who recalls taking an observation for latitude on LaBine Point where Eldorado Mines is now operating. Great Bear Lake, which lies partly within the Arctic Circle, is one-fourth the size of England. Navigation is limited to about 50 days a year, and in the winter, when temperatures as low as –50°F. prevail, the ice attains a thickness of 20 feet. The water is bluish-green and exceptionally clear. In August the surface temperature is around 43°. The lake abounds with fish, including herring, trout, and whitefish. Winds of gale velocity are the rule, and there is seldom a calm day. Trees do not grow higher than 40 feet and are commonly gnarled. Some specimens 30 feet high are 250 years old.

ELDORADO IN SUMMER

LaBine Point and the mine buildings, as viewed from an island in Great Bear Lake. The original pitchblende discovery was made at the location marked with a cross.



EARLY DEVELOPMENT WORK

The first work, done entirely by hand in 1931, consisted of opening up the veins along their outcrops. In the summer of 1932 some machinery was shipped in and an adit was then driven into the hillside to intersect No. 2 Vein about 100 feet below its apex. The two upper pictures show work in progress on this adit. At the lower left two workmen are whipsawing the first timbers. At the lower right is a view during the formative stages of the camp.

chain of vicissitudes. At the mine the difficulties were mainly physical: in the refinery the problem was one of scientific research.

The initial work at the mine, done by the five men who were there in the summer of 1931, consisted of excavating an open cut at the top of the hill where the discovery was made. In 1932 the first mechanical equipment was taken in by the water route at a freight cost from the end of steel to the mine site of $320 a ton, or a total of $64,000 for 200 tons. It included a 50-hp. diesel engine. As soon as this plant had been set up, a 415-foot adit was started at the base of the 115-foot-high hill to intersect No. 2 Vein. The winter of 1932-33 was spent in drifting on this vein to explore its possibilities. In the summer of 1933 another diesel, of 60-hp., and a 50-ton concentrating mill were shipped in, the freight bill for 1,200 tons of material being $288,000. Outside the company the impression prevailed that the expense of putting the mine on a production basis would be too great to be weathered, but there was no sign of wavering by those in charge.

The mill was at first operated on a test basis only, trial-and-error tactics being required to arrive at an adequate method of treatment. The addition of two more diesels in 1934 brought the mill power-plant capacity to 94 hp. and that of the mine to 186 hp. In the meantime work had been started on the sinking of a shaft on No. 2 Vein from the adit level underground. At first only a 50-hp. engine was available, and the work progressed slowly. If the drills ran, the pumps stopped, and vice versa. As frost penetrates the ground to a depth of 320 feet, the drilling problem during the first years of operation was complicated. During shaft sinking salt was used to prevent drill holes from freezing, and on the adit level hot water was fed to the drills. Water lines often froze in spite of all precautions, and ice had to be continually cleared away from haulageways and ditches. Upon being blasted, the ore frequently became reconsolidated and had to be blasted again.

During the summer of 1935, a total of 1,100 tons of freight was taken in at a cost of $165 a ton. This equipment made it possible to increase the daily production to 60 tons and to handle all of it in the mill. In the same year the company bought an airplane with a pay-load capacity of 4,400 pounds and turned it over to Leigh Brintnell to operate as a unit in his aerial freighting fleet in the Northwest Territories. By this move the expense of making air shipments from Edmonton to the mine was reduced from 72 to 35 cents a pound.

With more powerful machinery available, the shaft was sunk to the 500-foot level in the spring of 1936, and in the summer that followed a 256-hp. diesel engine was added. During the same season, parts of the mill and all the mine were electrified. New electrically lighted and steam-heated bunkhouses were built. By acquiring control of the Northern Transportation Company, the cost of freighting by water was reduced an additional $40, or to $110 a ton.

By the summer of 1937, the four main power units, all diesels, had a total capacity of 834 hp. One engine is direct-connected to an Ingersoll-Rand 900 cfm., 2-stage compressor, and the three others to General Electric generators which furnish power for the operation of the entire plant. Fuel oil from the field at Norman is now run through an 8½-mile pipe line which parallels the rapids of the Bear River, saving a portage of that distance that was interspersed with connecting water shipments. This improved method of handling has cut the cost of oil from 50½ cents a gallon to approximately 30 cents. Two 70,000-gallon storage tanks have been erected at the mine.

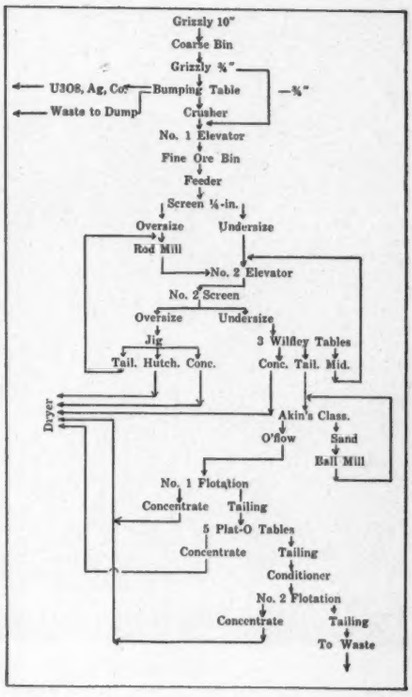
Altogether, about 40 metallic minerals have been identified at Eldorado, but the only ones of present commercial value are pitchblende, native silver, and chalcopyrite. The pitchblende yields radium and uranium, while chalcopyrite is, of course, a source of copper. With increasing depth, greater amounts of cobalt-nickel minerals and of native bismuth have been encountered, and it is possible that these may attain economic importance in the future. The pitchblende, which is a distinctive form of the mineral uraninite, was so named because of its pitch-like appearance. It is commonly of kidney-like structure and jet black except where impurities give it a brown cast. It occurs most often as lenses from 3 to 18 inches wide and not very long. The native silver is found principally in carbonate minerals, which, together with quartz and jasper, make up most of the vein material. Geologically, the region is in the Pre-Cambrian shield which covers a large part of Canada. There have been many intrusions of volcanic rocks, both of the granitic and basaltic types, and there are evidences of three separate stages of mineralization, with indications that the ore-bearing solutions were derived from the granites.

The mine has been opened to a depth of 500 feet below the adit level by means of a vertical, 2-compartment shaft from which levels have been advanced at intervals of 125 feet. During 1937 more than 8,000 feet of underground development work was completed. Drift faces are sampled after each blasting round, and the uranium-oxide content determined by electrometer measurements. In stoping the ore, the pitchblende can be readily seen and the economic width of excavation closely estimated without close sampling, except where there is a high-silver low-pitchblende ratio. Wherever possible, the placing of drill holes directly in pitchblende is avoided. High-grade ore is hand sorted in the stopes and hoisted for sacking. Broken rock and ore are raised in 1-ton cars to the adit level, ore being sent to the mill while waste is either trammed to the lake or held for filling worked-out stopes.

Three major veins of the numerous ones discovered are being worked. It has been fairly certainly determined that they have lengths of at least 4,000 feet. The irregular nature of the ore bodies and the inability to obtain reliable cores of the friable pitchblende render core drilling of little value in ascertaining the extent of the veins. Considering the remoteness of the operation, and the physical obstacles to mining, costs are remarkably low. Drifting and crosscutting average from $16 to $17 a foot, and stoping around $4.30 per ton of material broken. Approximately 100 men, nearly all of them young, are employed, mostly on one-year contracts, and they are paid from $4 to $8 a day, plus room and board. The daily ore production is now around 80 tons.

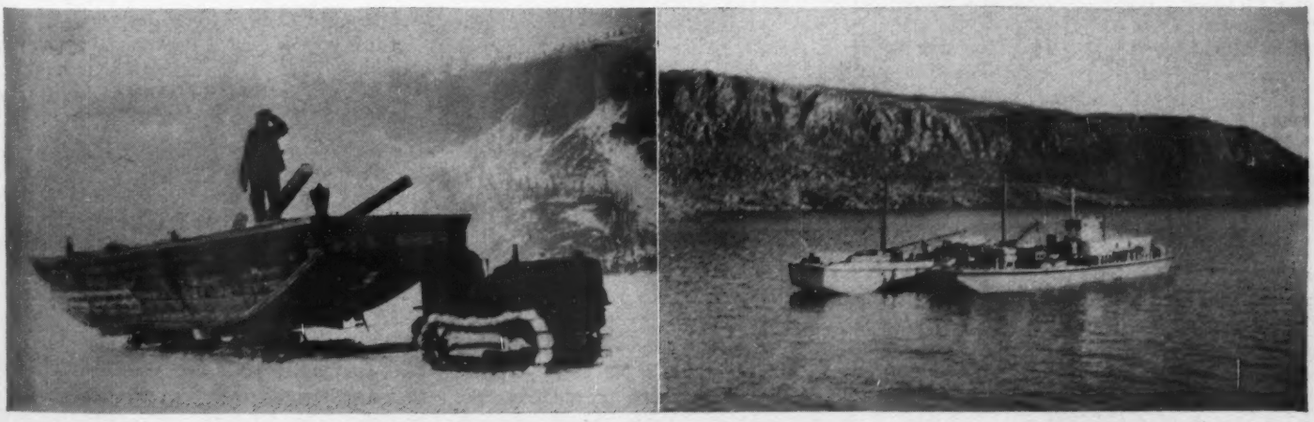
As heavy materials are generally shipped in during the brief water-navigation season, careful planning is required and major additions or alterations can be made only once a year. Most of the food supply arrives while the ice is out, although fresh fruits, vegetables, and meats are delivered by airplane throughout the year.

The ore, as broken in the mine, has an average value of around $124 a ton. By the time it reaches the mill, this has been materially reduced through hand picking of high-grade for immediate sacking. As there was little information available on the milling of similar ore, the company had to feel its way carefully. In carrying on the preliminary test work involved, the Department of Mines and Resources lent valuable aid. Pitchblende is not amenable to treatment by flotation, so it is segregated by gravity methods, its specific gravity ranging from 4.5 to 7, depending upon the content of uranium oxide. Some silver and copper minerals also are recovered in the operation, with further segregation of these by flotation. By decreasing the ratio of concentration, a higher percentage of silver can be saved; but for economy in shipping, a content of 500 ounces of silver per ton of concentrate has been set as the minimum. The total value of the concentrates runs around $2,500 a ton. The cost of milling a ton of ore is just under $4. Between seasons of open water the concentrates are sacked and stored. Each summer they are transported to Port Hope, the aim being to have a store sufficient to keep the refinery running a year. When it is necessary



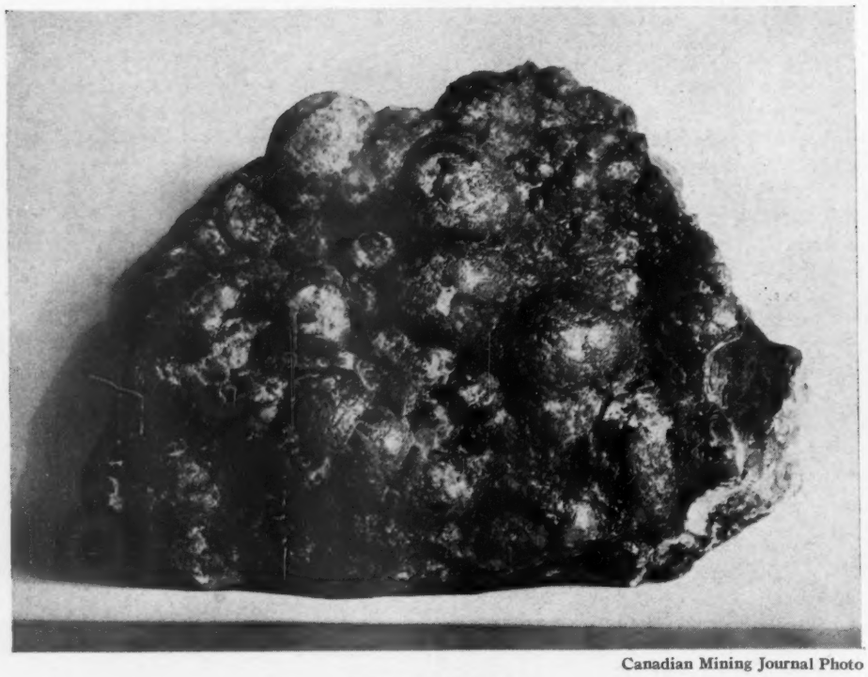
FLOW SHEET OF MILL

There was little information available on methods of concentrating a complex ore with a composition similar to that at Great Bear Lake, so the technicians gradually had to work out a process. Since the first mill was constructed, in 1933, the flow sheet has been changed three times. The latest one is shown above. Although more than 40 minerals have been found in the ore, the only ones at present of commercial importance are radium, uranium, silver, and copper.



FREIGHTING ON GREAT BEAR LAKE

Two contrasting views that show Great Bear Lake in an angry and in a placid mood. For more than ten months of the year, from September to July, its surface is covered with ice that attains a thickness of 20 feet.



Canadian Mining Journal Photo

PITCHBLENDE

Although it occurs in many forms, it is most commonly of reniform or kidneylike structure. When pure, it is jet black, but impurities frequently give it a brown color. It contains from 40 to 76 per cent uranium which, in turn, contains about 1 part of radium by weight in 3,000,000. Bear Lake ore is fortunately exceptionally free of mesothorium, which has been called radium's poor relation. Although not a member of the uranium series of elements, it resembles radium closely and is radioactive. It emits the same gamma rays that make radium so effective in the treatment of cancer, but loses most of its power of radiation in a few years.

to augment the supply, however, shipments can be made by air.

The development of an effective refinery process for the Port Hope plant was a scientific achievement of note. Here, again, the Department of Mines and Resources contributed valuable help; and during the several years that the problem was under investigation, many tons of ore were sent to Denver, Colo., to take advantage of research facilities available there. During the course of the studies, the company succeeded in retaining as head of its refinery operations Marcel Pochon, who had been trained in the Curie laboratories. With his assistance, a satisfactory method of treatment was evolved. It is, fundamentally, the Curie method, modified and elaborated as required by the characteristics of the Canadian ore.

Before discussing the refinery technique, it would perhaps be of interest to refresh our minds regarding the nature of radium itself. In 1896, Antoine Henri Becquerel, French scientist, discovered radioactivity and paved the way for the identification of radium and its related elements. In his laboratory Becquerel had many minerals that fluoresce when exposed to X-rays. Among these was a piece of uranium ore that he chanced to leave on a package of photographic plates. When the latter were developed, there were found to be black spots in the areas that had been directly under the ore. Becquerel's inquisitive mind sought an explanation, and this led to the discovery that uranium emitted rays that were even more penetrating than X-rays.

A year previously, a Polish girl, Marie Sklodowska, and a French youth, Pierre Curie, two of Becquerel's laboratory assistants, had been married. Jointly they set out to study the phenomenon of the mysterious rays. Madame Curie noticed that uranium ore gave off more radiation than did pure uranium and therefore concluded that the ore contained some other substance that accounted for this fact. Thereupon followed the isolation of radium, together with the less important radioactive element polonium. Further investigations resulted in the discovery of other radioactive elements and brought to light the significant truth that they were always found in association with uranium. It was also revealed that the proportion of radium to uranium in the ore was invariably the same, and that the ore always contained lead.

From the foregoing facts, Ernest Rutherford and Frederick Soddy, both then at McGill University in Montreal, determined that the age-old dream of the alchemists, transmutation of matter, was actually taking place in Nature. Uranium was breaking up, creating another element, and this was continuing through twelve distinct steps, with lead the final product. Radium is the sixth member of the series, its direct parent being ionium and its direct descendant radon. As radium disintegrates much faster than uranium, an equilibrium is established between the proportions of the two in the ore. Actually there are always approximately 3,000,000 parts of uranium to each part of radium. It follows therefore that the higher the percentage of uranium, the richer the radium content.

As the Eldorado pitchblende contains from 40 to 76 per cent uranium, it is easy to see why it is comparatively rich in radium. Even so, the actual quantity of radium is unbelievably minute. Assuming an average uranium content of 50 per cent, a ton of pitchblende contains 1,000 pounds of uranium and about 0.15 gram of radium. Accordingly, it takes 6½ tons of pitchblende to produce one gram (one twenty-eighth ounce) of radium. With the inevitable losses that occur in commercial treatment, approximately 10 tons of concentrates (derived from about 450 tons of ore) must be put through the Port Hope refinery to obtain a gram of radium. This has about the same bulk as a pin head.

It is of incidental interest to note that radium-bearing deposits furnish a means of determining the approximate age of the rocks in which they occur. As the rate of each step of disintegration is known, the amount of the final product, lead, that is present is a measure of the time that has elapsed since the ore was formed. Calculations indicate that the Canadian pitchblende is about 900,000,000 years old.

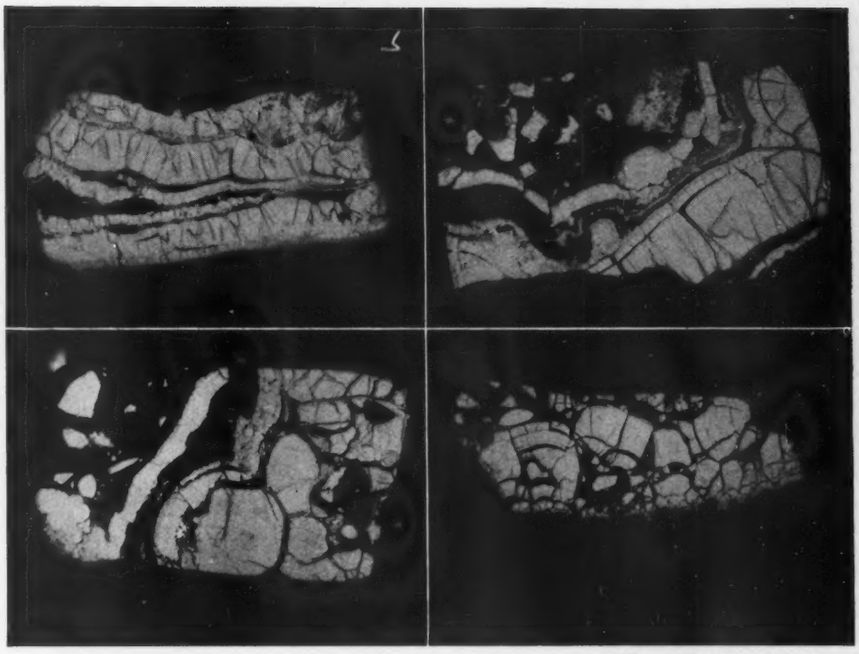
Three types of concentrates are made in the mill at LaBine Point. Two of these, containing essentially silver and silver-copper, are shipped to Trail, B. C., for smelting. The third, which bears the uranium, radium, and appreciable amounts of silver, lead, iron, and other elements, goes to Port Hope, where the principal object is to extract the one part of radium that is disseminated throughout 10,000,000 parts of the material handled. During the treatment the uranium and silver are of course also saved. Each canvas bag of concentrates, smaller than a 50-pound sack of flour, weighs 150 pounds; but its radium content is so small that it cannot be seen, weighed, or measured by ordinary means. Yet it is so valuable that even the bags are fed into the furnaces to capture the infinitesimal quantities of this precious element that may adhere to them.

There is little ponderous machinery in the refinery, and the process amounts virtually to laboratory technique applied on a commercial scale. At the outset the material is ground, roasted to drive out the sulphides and carbonates, and then reroasted with common salt to convert the uranium and silver into chlorides. Then comes a long succession of treatments with acid and alkaline reagents, with interspersed filterings to trap precipitated compounds. The seemingly impossible isolation of the mere trace of radium is rendered less difficult by the fortunate fact that it has a chemical twin in the element barium.

Knowing that the two respond in like manner to the same treatment, the chemists augment the barium sulphate in the concentrates with a quantity of barium chloride and employ it as a sort of chaperon for the radium. As one writer has expressed it, they send along 400,000 barium shepherd dogs, knowing that they will not lose the lone radium sheep.

Eventually, by elimination, selection, and purification, a joint radium and barium bromide is obtained. The barium and radium are separated by fractional crystallization. As radium is slightly less soluble than barium, it tends to crystallize first when the solution of the two bromides is partially evaporated. After ten repetitions of this process, the original ratio of 1 part radium to 400,000 parts barium is reduced to 1 part radium to 600 parts barium. Once a month the accumulation of this residue is subjected to further crystallization until the ratio is 9 parts radium to 1 part barium. This 90 per cent radium bromide is the final product, and is a white salt. Pure radium is a silvery metal, but no effort is made to produce it because all the known beneficial applications of the element can be made with it in the combined form.

Uranium is a valuable by-product of the recovery process. It is obtained as sodium uranate, both yellow and orange, and as black uranium oxide. The latter sells for around $1.50 a pound. Uranium salts are utilized in the ceramic industry to impart yellow, orange, dark green, and black colors to glazes, and the oxides are used in the manufacture of opalescent glass. It likewise acts as a mordant in dyeing and calico printing and in photography. Small amounts of uranium added to steel serve to toughen it, and the metal is accordingly employed in the production of certain tool steels.



From Canadian Mining Journal

RADIOGRAPHS OF PITCHBLENDE

Radium, of course, is put to its greatest and most beneficial use in the field of medicine. For this purpose it is ordinarily inclosed in small platinum tubes, or "needles," which are hermetically sealed with gold. Each needle may contain from 1 to 10 milligrams of radium. As radium cannot be weighed when thus packaged, its volume is determined by measuring the intensity of its radiations. The testing and packaging of radium costs around $500 a gram. It is done in London, which is the marketing point from which the compound is distributed to hospitals the world over.

In the treatment of cancer, radium is applied in a number of ways. Needles are sometimes held with adhesive tape directly over the affected area, or they are separated from it by wax, felt, rubber, or like materials. In certain cases, the cancer is "bombed" by placing over it 3 or 4 grams of radium fastened in an opening in a large block of lead. This tends to make for radiations of a more uniform intensity throughout the mass of the diseased tissue. Of the three types of radiations—alpha, beta, and gamma—that emanate from radium, the third is of medicinal value. The effect of the latter is to arrest multiplication of the cells of the cancerous tissue. No immediate benefits are noticed; but after several days the skin reddens as though it had been sunburned. Within a few weeks, if the patient has sought treatment before the growth has progressed too far, it disappears, leaving little or no scar.

Half of a given quantity of radium will disintegrate in about 1,700 years, and the remainder in a much longer time. As already mentioned, its immediate descendant is radon, a gas, and this also is efficaceous in the treatment of cancer. It has a life of only a week or two, however, so must be used without delay. In some places, where there are supplies of radium, this gas is collected as it is given off and compressed into tiny gold tubes called seeds. These are usually inserted in the cancerous growth by an instrument re-

HONORING ELDORADO'S DISCOVERER

This picture was taken at a banquet held in Ottawa, Canada, in November, 1936, to commemorate the production and refining of the first ounce of Great Bear Lake radium. From left to right: Gilbert LaBine; Harry Snyder, treasurer of Eldorado Gold Mines, Ltd.; His Excellency, the Governor-General, Lord Tweedsmuir; and Prime Minister W. L. McKenzie King.

Courtesy, Canadian Industries, Limited

SEALING THE PRODUCT

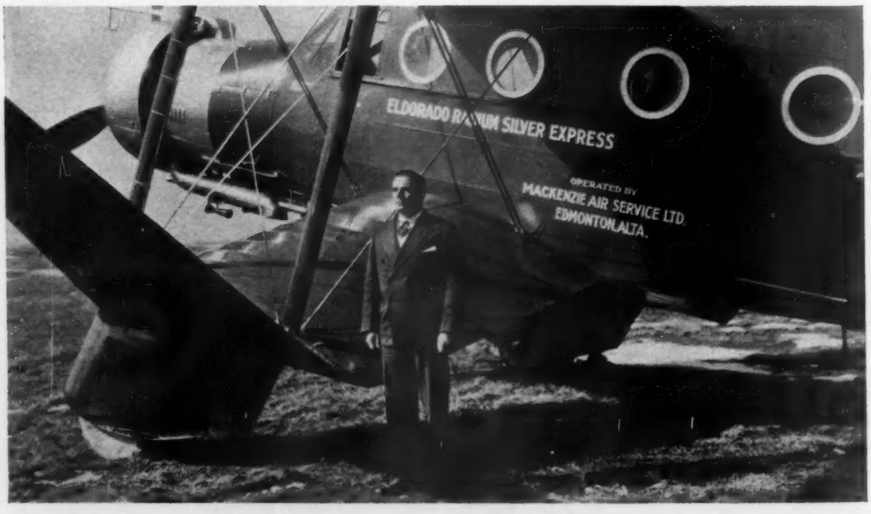
The radium bromide is placed in slender glass tubes which are sealed with a flame. The one shown here (left) holds about $2,000 worth of the powder. The glass tubes are stored in lead-filled brass tubes which are inserted in a solid block of lead (right). They are shipped in lead containers such as that seen at the lower right. After being tested by the National Research Council and having official strength labels attached to them, the glass tubes are sent to England where the bromide is converted to a sulphate and sealed in needles, plaques, or bombs for hospital use. Usually the needles are made of iridio-platinum, which screens out the alpha and beta rays and some of the softer gamma rays. It will be noted that those handling the radium are wearing rubber gloves to protect them in some measure from the radiations. Usually, also, they work behind an interposed slab of lead and handle the tubes of radium with forceps instead of fingers.

sembling a hypodermic needle, the patient being given a local anaesthetic.

Aside from its application in medicine, radium is employed in making luminous paints, and it has been utilized in the field of engineering to detect flaws and holes in welds and castings. X-rays ordinarily serve for this purpose, but they are not penetrating enough in the case of thick sections. Radium rays are effective for inspecting iron up to 10 inches thick.

The Port Hope refinery produced its first ounce of radium in November, 1936. In recent months its capacity has been tripled, and on a 3-shift operating basis it can treat 150 tons of concentrates a month. It is reported, however, that for the present the plant will handle somewhere between 50 and 100 tons. This would insure an annual output of around 100 grams of radium valued at approximately $2,500,000. It was estimated a year ago that not more than 600 grams of radium had been isolated since the element was discovered, and that nearly half of that amount had been lost or dissipated through the use of luminous paints.

Wind-swept LaBine Point takes rank as the fourth commercial source of radium discovered. The first was at a smelter, in what was formerly Bohemia, where uranium had been accumulating in a slag dump for many years. It still produces a small amount of radium. Next were worked the carnotite deposits of Colorado and Utah in the United States. For a time these gave rise to a profitable industry, which met its doom with the finding of the vastly richer pitchblende ores in the Belgian Congo. The output of the latter deposit has been shrouded in secrecy; but it is believed to have reached as much as 30 grams a year. The latest published figures available give the area a production of only 6.7 grams in 1933. It is possible that it will meet the same fate through the development of the Canadian enterprise that it brought upon the Colorado interests. Every indication points to a long productive life for Eldorado Mines, Limited; but it is within the bounds of possibility that some other intrepid soul such as Gilbert LaBine will some day find an even more lucrative source of the most valuable substance yet discovered in the earth's crust. It is doubtful, however, if anyone will ever turn up a more romantic true story than the one La Bine welded together amid the inexorable ice-clad northern expanse of Canada.



WINGED TRANSPORTATION

This airplane, capable of carrying a pay load of 4,400 pounds, was purchased by the mining company in 1935 and makes regular trips from Edmonton, Alta., to LaBine Point. Aside from human cargo, it takes fresh foods to the isolated mining camp during the more than ten months of the year that water transportation is impossible. On occasions it also hauls bags of concentrates back to Edmonton, although these are ordinarily stored at the mine and shipped by water during the summer.

How Air Aids Our Battle Fleets

Photographs, courtesy U.S. Navy Recruiting Bureau

ADMIRAL W. S. SIMS

who, as a young naval officer, introduced a new method of sighting and loading guns that enabled them to be fired ten times as fast as before and with equal or greater accuracy. A distressing accident, caused by powder gases from the breech of a gun, almost forced abandonment of Sims's scheme; but a way was found to make it safe by utilizing compressed air to clear the bores of gases after each firing. Modern battleships have aboard from two to four compressors which deliver air at pressures of from 150 to 200 pounds for this service. They are often arranged also to supply lower pressure air for operating pneumatic tools and other equipment used in ship maintenance and repair work.

Yates Stirling, Jr.
Rear Admiral, U.S. Navy, Retired

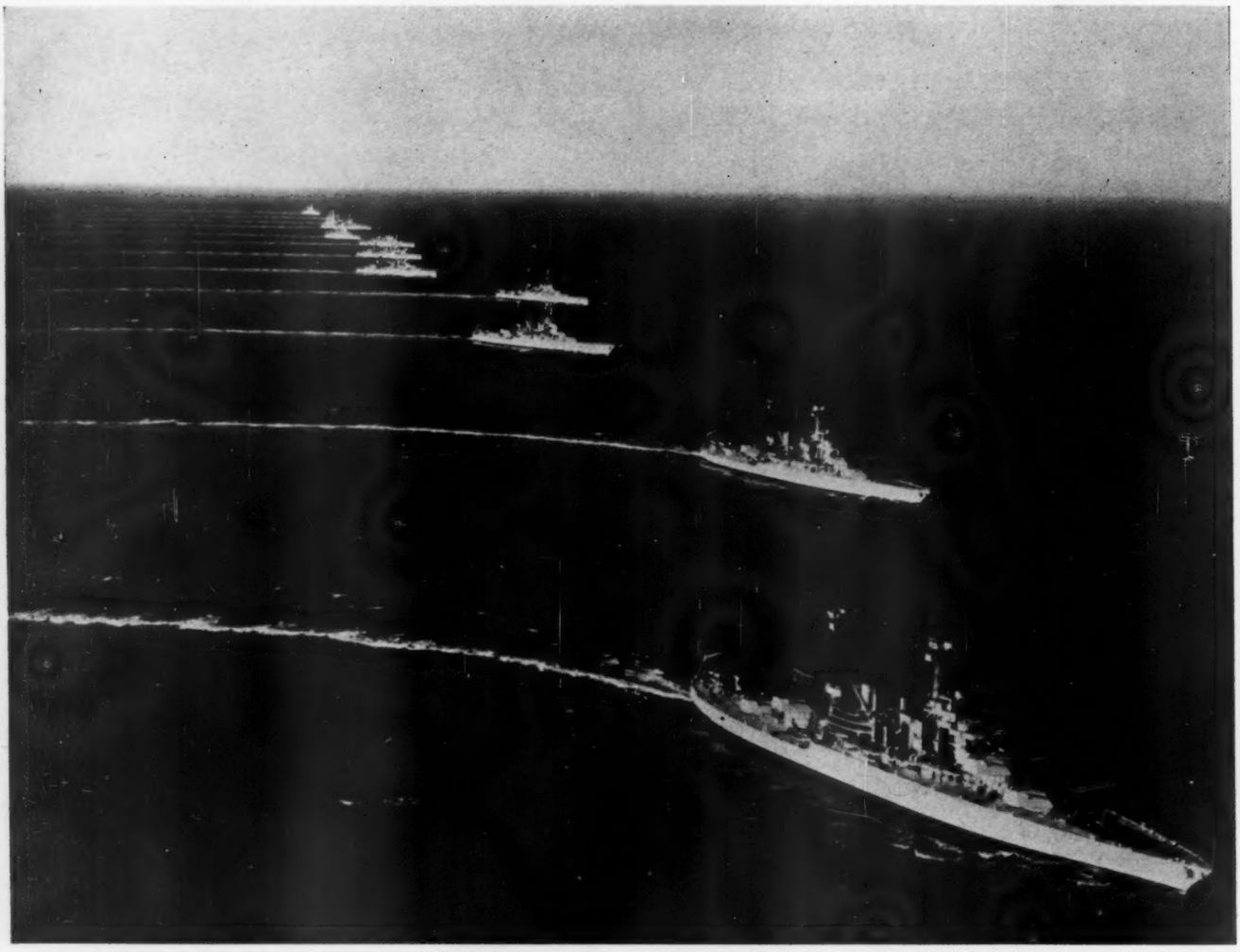
COMPRESSED air, we are glad to relate, does most of its work in peacetime pursuits. It aids mankind in countless ways, and every sane individual cannot but express the hope that its service as a destructive agency will be minimized. Nevertheless, compressed air is a vital factor in various instruments of warfare, especially on the seas, and it would seem to be of interest, if only as a matter of information, to describe some of its chief uses in this field.

The high-power naval gun, the automobile torpedo, the submarine, and the airplane with its explosive bombs are all, in greater or lesser degree, dependent upon compressed air for their functioning. Without it, none of them could have reached their present stage of efficiency. For the battle at sea between warships there stand out most prominently the great turret guns and the torpedo. The latter, most of us know, could never have come into the world if man had not succeeded in harnessing the harmless air and converting it into a power that enables it virtually to move mountains. Compressed air is the force within the shell of the torpedo that gives it, through its turbines, the capacity to travel at speeds up to 30 miles an hour and for distances up to 5 miles under its own power.

Compressed air's contribution to the modern turret gun far exceeds that to the torpedo, for without the latter weapon war on the seas would be almost as destructive. Actually, the torpedo is most merciful, compared with the gun. The torpedo sinks a ship, it is true, but the ship dies slowly and calmly, disappearing beneath the waves often after sufficient time has elapsed to permit all the crew to escape. In the battle at sea, the greatest destruction and loss of life is caused by the gun. The gun is guilty of greater havoc. Its shells penetrate into the magazines of ships, exploding the powder there and destroying the vessel completely, with the consequent loss of all hands, as happened to three great battle cruisers at the battle of Jutland.

The big warship contains all manner of machinery. To enable the making of necessary repairs, there are carried on board facilities similar to but on a smaller scale than those provided for industrial plants ashore. In the engine room or other locations below decks are installed large compressors, and the air from them is piped to parts of the vessel where compressed air is needed. Air riveters, chipping hammers, pneumatic drills, etc., are used daily by the artificers among the crew. These are the industrial services of compressed air. They are all important; but the military applications are far more so, aside from being more romantic and infinitely destructive.

The military value of compressed air in so far as guns are concerned was not discovered until after many daring officers and men of our navy had laid down their lives in very distressing turret accidents in the cause of progress. More than 30 years ago, when the monarchs of the seas were of the class of the now obsolete battleships *Alabama* and *Wisconsin*, a lieutenant named Sims—the same who, as admiral, com-



FIRST LINE OF DEFENSE

United States battleships returning to port after completing maneuvers in the Pacific Ocean.

manded our naval forces in Europe during the World War—undertook to increase the fighting capacity and effectiveness of our war fleet. His optimistic claims attracted the attention of the President of the United States, then Theodore Roosevelt. Those claims sounded so spectacular and impossible that even the hot-headed, impetuous "Teddy" became doubtful of Sims's sanity and ability to perform what seemed to be miracles. This superenthusiastic young naval officer astonished both the president and the navy by offering to increase the rapidity of the fire of all our naval guns by more than 1,000 per cent and their hitting efficiency by as much and more.

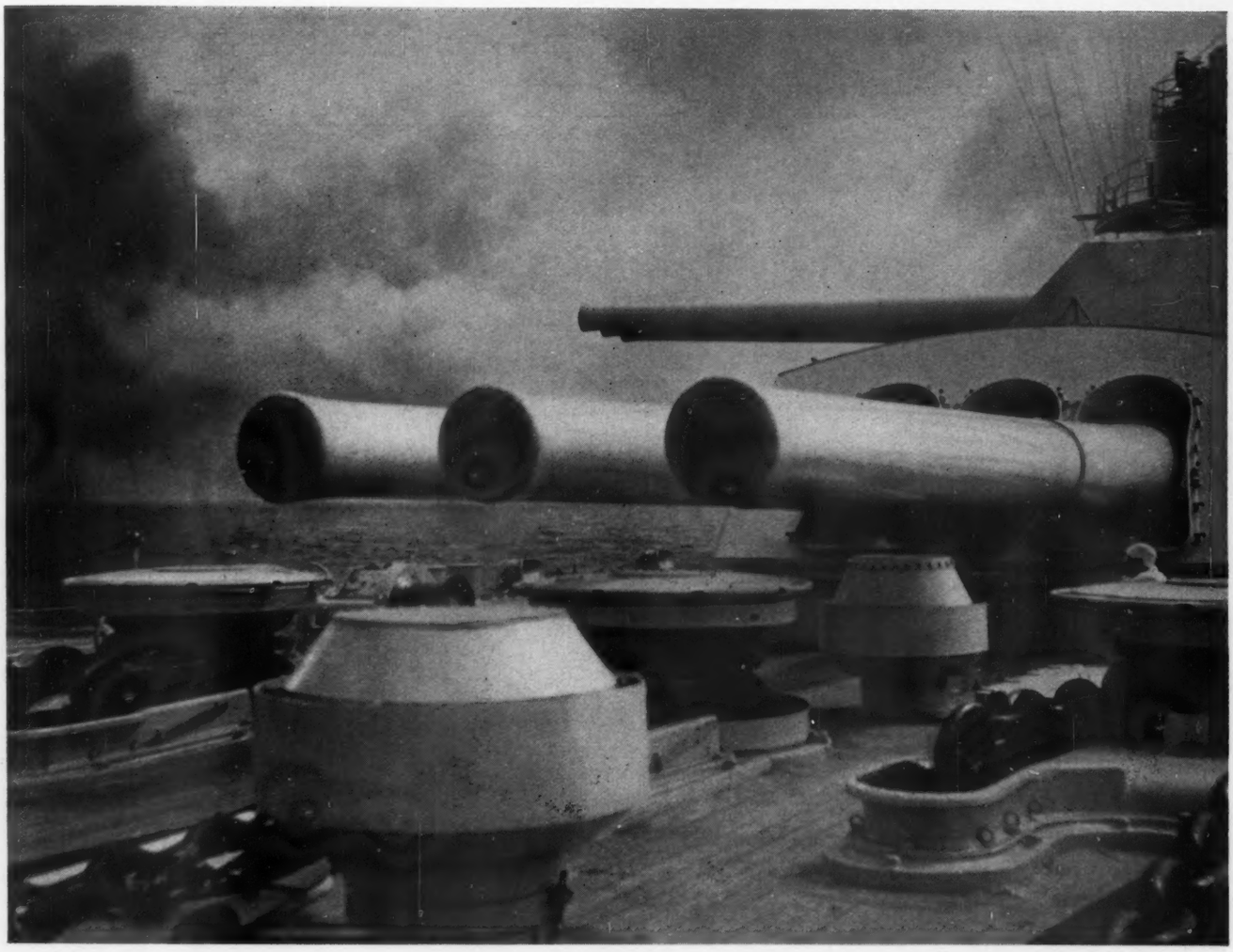
Sims was given full authority to put his plan into operation. It was simple, as we know today. The scheme was to use certain at that time secret instruments to train the men that sighted and fired the guns to hit the target, and also to decrease the loading interval for turret guns by means of a new method from once in five minutes to once in less than 30 seconds. It sounded incredible! It can well be imagined that every motion involved in loading the big guns had to be speeded up to accomplish this. In spite of faulty material, inaccurate sights, and the skepticism, amounting almost to open resistance, of the higher ranking naval officers who looked upon Sims as an officious young upstart, he achieved what he set out to do. But even Sims was unaware of an insidious, cruel enemy lying in wait to confound his marvelous achievement and to give his enemies an opportunity to bring calumny on his head.

The previously turtlelike movements of the men in the turrets while loading the big guns were stepped up by Sims to the pace of the hare. The huge breech plugs were being flung open even before all the powder gases had escaped out of the muzzles. The big shells were rammed home with lightninglike speed; powder packed in silk bags followed; and then the breech plugs were slammed shut almost quicker than the eye could detect.

Lurking inside the bores of the guns for some time after the discharge was a gas of which the experts on ballistics were not aware. The turret crews, however, in ramming home the shells, had observed a white oily appearing smoke in the bores. When the wind happened to be blowing into the muzzles of the guns, this oily smoke had occasionally drifted from the breech into the turret; but, unconscious of the danger, no one took account of it. On the fatal day, an incandescent bit of unconsumed powder bag clung to the inside of the powder chamber during target practice carried out according to Sims's methods.

Then, suddenly, the oily white smoke revealed its character. Uniting with oxygen of the air, and ignited by the hot particle, the gas burst into flame. It set fire to two powder bags—several hundred pounds—at the breech of the gun ready to be pushed home after the shell had been seated. The inside of the turret at once became a roaring furnace. Two more powder bags beneath the gun ignited, and the flaming grains, falling down the open turret into the handling room below, further added to the horror by setting off the powder that was held there ready to be sent aloft to the guns at the word of command. In all, nearly 50 officers and men lost their lives.

As was to be expected, the reaction against the innovations of the progressive William S. Sims was immediate and vio-



"COMMENCE FIRING"

Hurling steel projectiles, the turret guns of the U.S.S. "Pennsylvania" go into action.

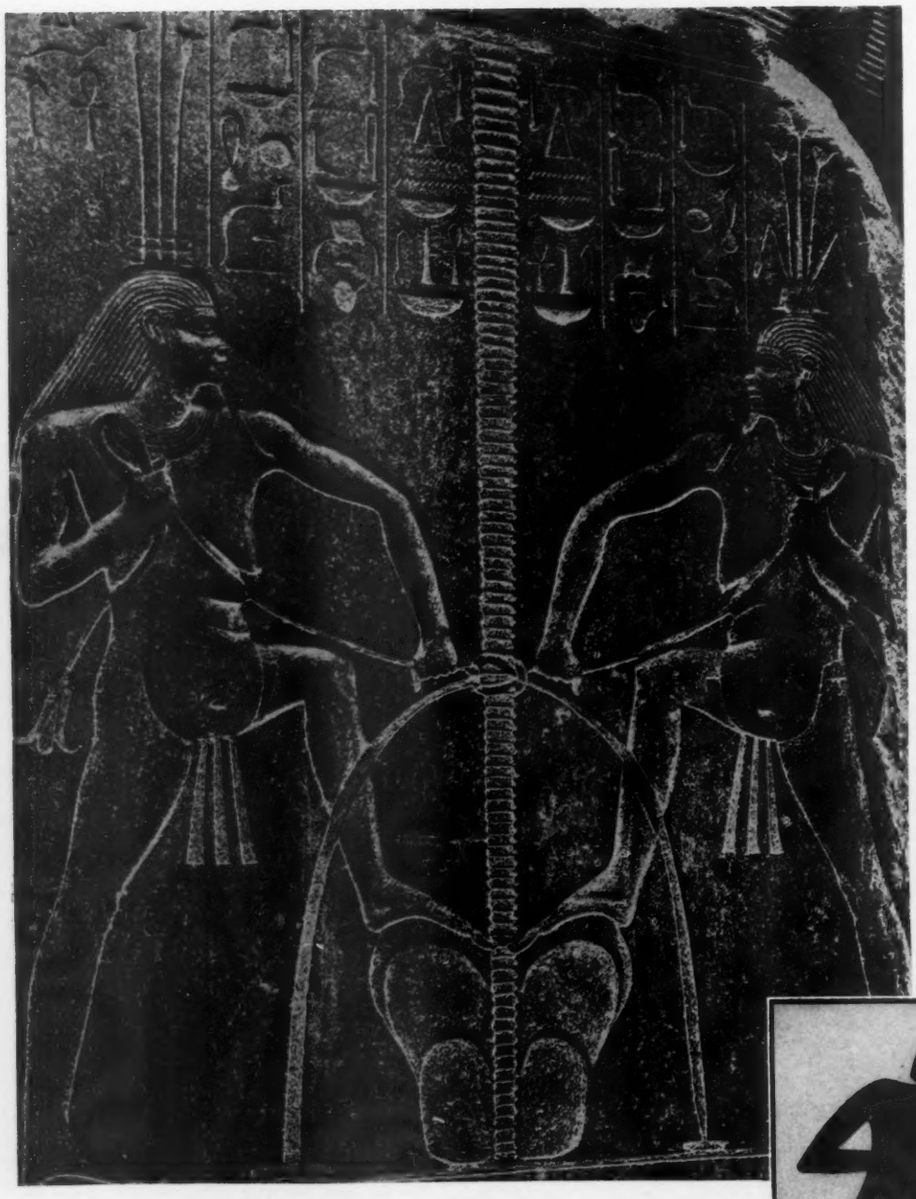
lent. The spectacular advance in our naval gunnery stood to be sacrificed on the altar of conservatism. By the new gunnery methods, the rapidity and accuracy of the gunfire of the fleet had been increased by 900 per cent. Therefore Sims had given the nation ten fleets where before it had but one. "Mr. President," Sims is reported to have told the chief executive, "will you throw away nine fleets before making every effort possible to defeat this mysterious enemy to fast shooting?"

Sims's own plan to discount the gas was actually in line with what the ordnance experts finally worked out. Once the enemy had been discovered and driven into the open, it held no terror for Sims and the men of our fleet. Compressed air is the agency used to overcome it and to render it harmless, although it must be remembered that the gas is still present and ready to take a heavy toll of life should safety precautions be neglected.

The remedy was applied crudely at first. Compressed air was delivered by a flexible hose from the torpedo air banks and was used to blow the oily smoke out through the muzzle—the powder being kept at a safe distance until that was done. This necessarily slowed down the loading, and a more scientific and quicker means was sought and found. As finally carried out, the general idea is to form a helix of air just in front of the mushroom head of the breech plug of every gun using powder in bags. While the plug is opening, air at a pressure of about 150 pounds enters the bore through several small holes drilled through the gun at a point where the air will be behind the oily smoke and will expel it toward the muzzle at considerable speed. The valve admitting the air is opened by a cam on the face of the plug and closed by hand after it is observed that every trace of gas has disappeared from the bore of the gun. Sims, backed by "Teddy" Roosevelt, won; and our efficient gunnery today is his crowning achievement.

So we see that compressed air is the vital factor in many naval weapons. Without it, the big warships would still be firing their great guns at a snail's pace. Torpedoes would not exist. Therefore no one would have thought of having destroyers; and the submarine using compressed air also to blow ballast tanks and to burn the fuel in its engines would never have arrived to plague the great ships on the sea. Even the airplane, with its powerful engines to enable man to lift himself by his boot straps, could never have become a reality had man not learned how to compress the air he breathes.

Note: The opinions and assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the U. S. Navy Department or the naval service at large.



TYPES OF EARLY DRILLS

At the left is a reproduction of a carving on an Egyptian tomb that shows workers setting up a large strap drill of the type that is believed to have been used for most of the heavy quarrying operations. The picture just below illustrates the method by which stone vases were hollowed out in ancient Egypt, while the bottom view, which was taken from a tomb painting, depicts a single-hand bow drill in service.

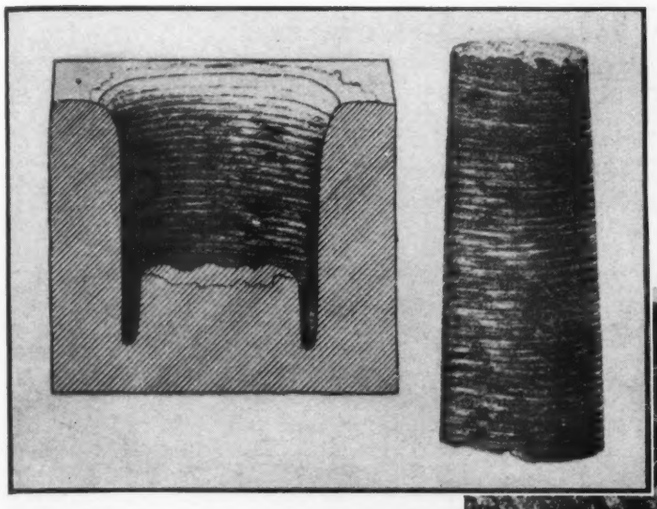
How Ancient Peoples Drilled Rock

Herbert Manchester

DRILLED beads, shells, and vases discovered by archaeologists are evidence of the fact that drilling of small objects was practiced even before the dawn of written history. In the hieroglyphics of the earliest Egyptian dynasties are pictured stocks of drills which were evidently turned between the palms of the hands. The stone vases or urns of the first dynasties were many and varied; and a bas-relief of a later Egyptian period shows a workman boring out a vase by hand with a drill which was weighted on top. The earliest cutters or bits used for this purpose were crescent-shaped flints or curved blocks of basalt.

In the Fourth Dynasty, when the Pharaohs began to build the great pyramids in the belief that the soul would live as long as the mummified body was preserved, heavier drilling suitable for rock was introduced. To increase the power, the drill was worked by a bow. The thong of the bow was wrapped around the drill and kept taut by the spring of the bow, the drill being rotated when the bow was drawn back and forth. The top of the drill turned within half of a hard nut that was held in position by one hand. The cutting bit was of flint, or of other hard material, and was set in the bottom of the stock.

The bow drill was the first machine to change reciprocating into rotary motion. It was so practical that it remained in common use for more than 4,500 years. In the beginning it was utilized for drilling



TUBULAR DRILLING AND OLD QUARRY

The rock specimens pictured at the top were drilled with tubular drills and show a drill hole, with part of the core remaining in the bottom, and a core. These tools were usually made of copper of the hardness of bronze. The lower view is of an early Egyptian quarry at Assuan. The rocks in the foreground on both sides still bear traces of drill marks.

wood, pottery, and copper, and was of aid in getting out and working the great stones for the pyramids. In his book, *Pyramids and Temples of Gizeh*, W.M.F. Petrie says that the stone beams over the sepulchral chamber in the Pyramid of Khufu and over the granite chamber in the Third or Menkaura's Pyramid still have in them halves of drill holes.

Besides the bit drill, a tubular drill was invented and applied as early as the Fourth Dynasty. It was usually made of copper which, in the impure state then common, was as hard as bronze. The bite of the drill was perhaps intensified by sand, which was more effective when kept wet with water poured down the hole. With the assistance of this abrasive material even a wooden drill was adequate for soft stones like limestone. The tube cut a circular hole and left a core, which was usually broken off. It saved work in making large holes, and was employed for drilling rock and for hollowing stones, urns, vases, and the like. A number of specimens have been discovered in which the core remains in whole or in part, indisputable proof of the fact that tubular drilling was practiced many hundreds of years ago.

Another method of drilling made use of a strap instead of the bow previously described. The strap was wound around the drill and was drawn back and forth by workmen, one on each side. Thongs were run from the drill to the ground to hold the tool upright, and weights were placed on top of it to increase the effectiveness of the bite. The strap drill required two workmen, and therefore became the symbol of the union of Upper and Lower Egypt. For this reason it appears in all sorts of symbolic forms in the different tombs, but in some cases is scarcely recognizable.

The strap drill was especially suitable for heavy drilling, and after its introduction was adopted for work in the quarries. These were situated either across the Nile or up the river at Syene or at Assuan near the first cataract. At both places are blocks of stone that still show traces of some of these drill holes. From markings in the quarries, Petrie inferred that, in order to control the fracture, it was the practice not only to cut a groove along the surface in the direction of the natural cleavage but also to drill holes every couple of feet right through the mass. According to that authority there are still to be seen in these ancient quarries stones with halves of such holes plainly visible on the top.

The exact methods by which the early Egyptians fractured the rock are unknown. It is possible that wedges of copper were set in the drill holes and hammered in unison until the blocks broke off. This was the means commonly employed a century or so ago, except that steel and not copper wedges were used. As the "plug-and-feather" method it is still practiced to some extent. Again, the blocks might have been broken off by plugging the holes with wooden wedges and wetting the wood to make it swell. After they were quarried, the blocks were cut to size by the same means of drilling, wedging the holes, and hammering the wedges. Saws also were utilized, but usually only where a stone of plainer surface was desired or in connection with the softer sandstone.

As soon as the blocks had been floated down the Nile on barges, they were drawn on sledges over a causeway to the pyramid by hundreds of men. Parts of some of these causeways still remain; and one bas-relief pictures the statue of Dhuhotep being transported in this way. In general, the huge stones were only partly dressed at the quarries. Near the pyramids they were again drilled, split, and dressed before being put in position. How they were raised, is still a mystery, for in the bas-reliefs, which depict so many forms of labor, are shown no levers, no pulleys. Herodotus wrote that the construction of one of these roads, itself, required ten years of labor. Perhaps it formed an inclined plane which was progressively raised as the pyramid was built.

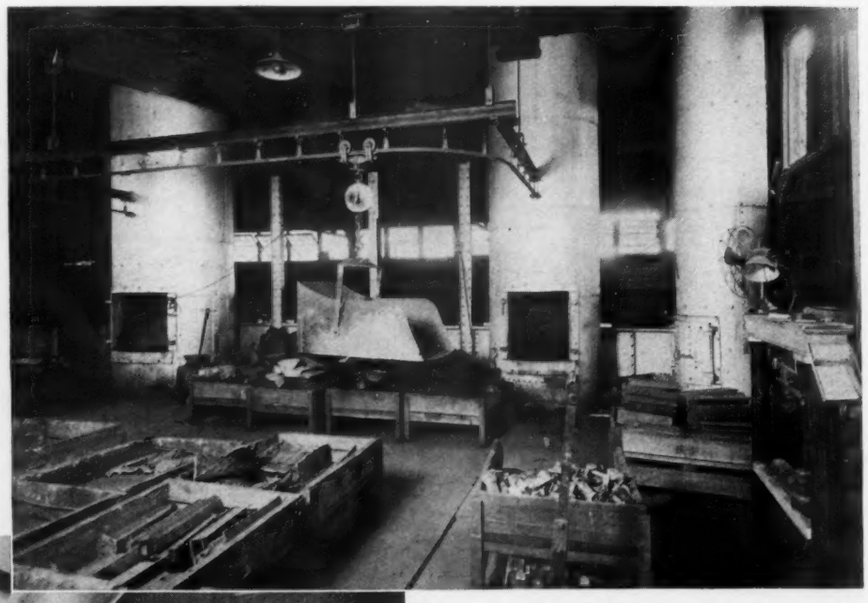
Weighing the Air Blast Makes for Better Iron Castings

Orville C. Hoover
Metallurgist, Oberhelman-Ritter Foundry Company, Cincinnati, Ohio

IN THE past very little interest has been shown by the foundryman in the most efficient unit for the proper delivery of air into the cupola. Today, however, owing to competition and small margins of profit, the more progressive foundries are making thorough studies of all their operations in order to reduce costs to the point where they can operate profitably even under present conditions. The writer will attempt to show the possible savings that can be effected by the use of properly designed modern equipment, together with capable supervision at the cupolas. True melting ratios, based on monthly operations, will be presented later in the article as proof.

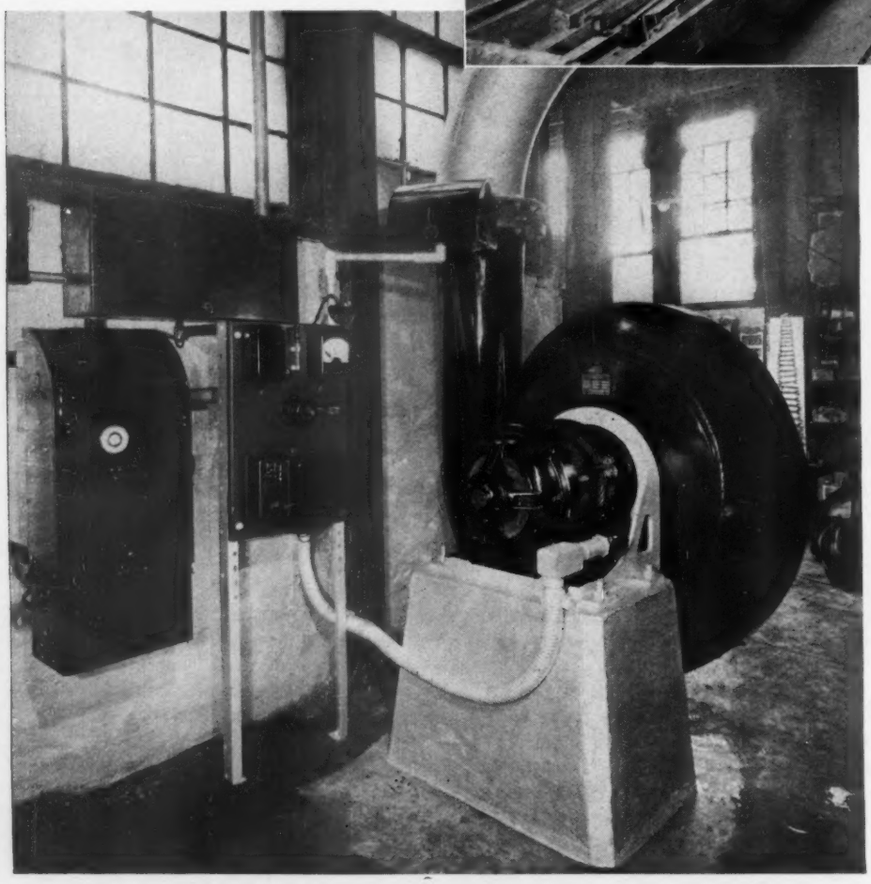
Our foundry has two cupolas: No. 1, which is lined to 48-inch diameter, and No. 2, which is lined to 60-inch diameter. After several months of study by the writer, it was considered advisable to provide a new centrifugal blower with automatic air-weight control, which is illustrated in two of the accompanying photographs. The views show the complete installation; and particular attention should be given to the small space required by this type of blower. As can be seen, the blower pipes are arranged so that either cupola may be operated independently of the other, or both simultaneously, as conditions warrant. In our case, the pouring of larger castings formerly necessitated the use of both cupolas. Since the installation of the new blower equipment, castings of the same size are poured with only one cupola in service. Power costs have been reduced in consequence. The operation of a single 50-hp. motor making 3,550 rpm. has resulted in a saving of approximately 25 per cent, as compared with the operation of the two motors that were previously required. Maintenance costs, likewise, should be reduced.

It can be seen in the illustration of the charging floor that all precautions have been taken to insure accurate weighing of



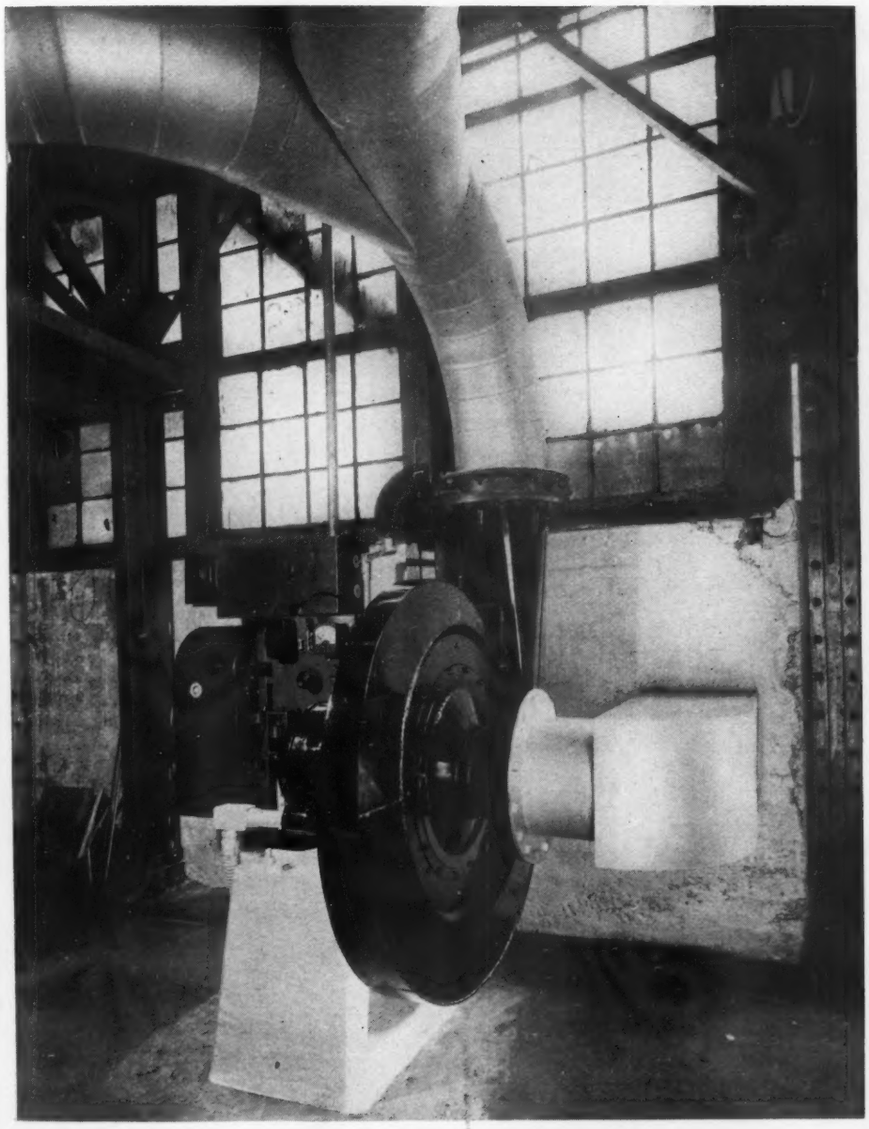
CUPOLA CHARGING FLOOR

In the right foreground are floor scales with a box of iron in place for weighing. Coke and limestone charges are weighed by scales suspended from the monorail system that serves the two cupolas shown with their charging doors open.



SOURCE OF AIR

This Ingersoll-Rand Motorblower has effected worth-while economies and improved the quality of the castings produced at the Oberhelman-Ritter foundry in Cincinnati, Ohio. It is a 50-hp. unit with a rated capacity of 6,000 cfm. of air at 1¼ pounds pressure. Attached to the blower discharge at the window line is the blast-gate mechanism by which the weight of the air delivered is automatically regulated.



ANOTHER VIEW OF BLOWER

This picture shows that only a small amount of floor and room space is required to accommodate the unit. The intake for air from outside the building is at the right. Overhead is seen the branching discharge line through which air may be delivered to either one of the two cupolas, or to both of them simultaneously.

all materials that go into the cupola. The iron charges are weighed in boxes on the floor scales, a complete charge being weighed before the box is removed from the scales. Coke and limestone are weighed on scales running on an overhead monorail system. The coke and the limestone are dumped into the cupola directly from a coke tub, but all iron is carefully charged by hand.

Often we hear of foundrymen operating on a 10-1 iron-coke ratio. While this ratio is possible, if we consider the coke in the charges only, we feel that a truer picture of the operation is obtained in our case if we include the coke in the bed and give credit for the iron and coke in the drop. True ratios can be arrived at only by weighing all the iron charged and all the coke charged, and then weighing the iron and the coke found in the drop at the end of the heat. This drop is subtracted from the total charge, and the result gives the actual poundage melted. For example, actual figures of Heat No. 105 show that 45,000 pounds of iron and 8,320 pounds of coke were charged. At the end of the heat the drop contained 710 pounds of iron and 1,045 pounds of coke. Actually, then, there were 44,290 pounds of iron melted by the use of 7,275 pounds of coke. The true ratio is, therefore, 44,290-7,275 or 6.09-1. As a measure of thermal efficiency the foregoing method is not correct, as the coke used has already melted the iron in the drop. However, we feel that a ratio that takes into account the melted iron not used gives us an index of the operating efficiency of our cupola.

Since the installation of the new centrifugal blower our operation has shown an iron-coke ratio of nearly 6-1. This is considered eminently satisfactory, because prior to the use of the new equipment the ratio was in the neighborhood of 2.4-1. The blower was placed in service on April 7, 1938, and has not only effected a very substantial saving in coke but has also helped to bring about a pronounced improvement in microstructures and a much better control of chemical analyses.

Castings in our foundry range all the way from 1 pound to 20 tons, and all are cast to rigid specifications both as to wear and strength. Many alloy castings are made that require careful and delicate control. Since the installation of the new blower equipment we have been able to meet any and all casting specifications demanded by our customers.

Few foundrymen realize the importance of proper air delivery to the cupolas; but it is a major foundry problem and must be considered as such. Reliable investigations prove conclusively that most blowers are actually delivering into the cupola more air by weight than the combined weight of the iron, coke, and limestone charged into the cupola. Our operations have shown that 370 pounds of air per minute in the 48-inch cupola and 500 pounds of air per minute in the 60-inch cupola are sufficient satisfactorily to melt charges of iron varying from 100 per cent steel to 0 per cent steel. These volumes of air have given us the best results both as to the coke ratios obtained and as to the quality of the product.

Our records show the following comparative figures: With the old equipment, in December, 1937, we melted 960,100 pounds of iron with 349,046 pounds of coke, or 2.46 pounds of iron with each pound of coke. In June, 1938, when the new blower was in service, 930,750 pounds of iron were melted by the use of 179,609 pounds of coke. This gave an iron-coke ratio of 5.18-1, or more than double the former iron-coke ratio. While this may still seem to be rather low to some, it must be considered that more than 60 per cent of our total iron mixtures contain more than 50 per cent steel. This has permitted us to make very large castings with a Brinell hardness in excess of 220 that are, nevertheless, readily machinable. Tensile strengths range from 48,000 pounds per square inch to 68,000 pounds per square inch, and yet the castings produced possess a ductility that is not found in normal cast irons.

Basing figures on comparable outputs, the savings effected in coke alone will pay for the new blower equipment in less than six months. In addition, labor costs in connection with the operation of the cupolas have been cut 25 per cent by eliminating nearly 50 per cent of the coke handling. Further savings have been made possible by the faster melting rate of the cupolas, enabling the workmen to finish on time and thus taking costly overtime from the payroll.

Boat Reaps and Destroys an Unusual Crop

G. H. Dacy

THE "KENNEY" AND THE MACERATOR

The vessel at the top is now at work, 24 hours a day, on the annual job of keeping our coastal waterways between Florida and Texas open to navigation by the removal of the profusely growing water hyacinth. The quantity destroyed each year is said to reach the staggering figure of 2,625,000 cubic yards. Forward of the deckhouse is seen the Type 30 compressor which supplies the air by means of which the rams of the macerator are actuated. The chain conveyor, aft, dumps into the hopper on the platform amidships, whence the plants are fed to the crusher underneath. The latter is shown assembled in the shop of the Equitable Equipment Company, Inc.

TO THE many unusual applications of compressed air has been added a new one: it is rendering effective service in the destruction of the water hyacinth—an aquatic plant that is indigenous to some of our southern states where it has greatly hampered shipping. Touring motorists and travelers marvel at the gorgeous purple flowers when first they see these "pretties" afloat on the surface or temporarily anchored in shallow water; but to rivermen and pilots of freighters or passenger boats it is the worst of plant pests in that far-flung stretch of coastal country extending from Florida to Texas. It grows luxuriantly, and has to be removed regularly from navigable streams to prevent it from obstructing the fairways or channels.

The destruction of the water hyacinth by mechanical means is the newest method of waging war against it. Before its introduction, it was the practice in Louisiana and Mississippi to spray chemicals rich in arsenic on the plants before the seeds had a chance to mature. In Louisiana alone 1,000,000 square yards of hyacinth-infested waters was thus gone over monthly during warm weather at a cost of approximately $80,000 a year. Several weeks after the treatment, the plants wilted, died, and sank to the bottom. Though effective, there was an objection to this method, for the chemical solution not only killed the vegetation but also was harmful to man and beast. The death of the expert in whose honor the *Kenney*—the vessel recently put in service to clear the waterways—was named was attributed by physicians to arsenical poisoning contracted during the plant-spraying operations. Livestock which ran at large and which ate of the treated hyacinths—a succulent plant much liked by cattle—almost invariably succumbed.

After several years of experience, most of the states affected frowned upon chemical warfare as a means of controlling the hardy vegetable growth, while Florida legislated against it right from the start. The use of spray barges has therefore been discouraged. Instead there has recently appeared the first of a fleet of "destroyers" designed by the First New Orleans District of the U. S. Corps of Engineers and built by the Electric Equipment Company, Inc., of New Orleans, La.

The *Kenney* is a self-propelled, all-steel barge of the conventional twin-screw, tunnel-stern type. It is 80 feet long, 24 feet wide, and has a draft of 4 feet. Securely attached to her bow is an endless chain conveyor the outermost end of which is submerged several feet below the surface while the upper end is held amidships above a special hopper. It is made up of three sections each 5 feet wide and 36 feet long, and the underside is equipped with steel teeth that cut the entangled vegetation and rake it up the conveyor trough into the hopper, whence it is fed to a powerful macerator stationed beneath it. This consists essentially of two rolls one of which is held

against the other by hydraulic rams exerting a pressure of 40,000 pounds. An Ingersoll-Rand compressor, mounted on the deck of the barge, supplies the power that actuates the rams. It is operated by a 2-hp. waterproof motor and is adjusted to maintain a pressure of 250 pounds per square inch. The rollers are hollow to reduce weight, are provided with stout teeth to assist feeding, and are rotated at as much as 21 rpm. by a 25-hp. motor.

The chain conveyor is driven at a speed of from 30 to 100 feet a minute by a 25-hp. motor. This is reversible, so that the conveyor can be backed up in case of necessity. And to free the boat itself, should it be held fast by a hidden snag, there is a small winch on board capable of exerting a pull of 3,000 pounds. Swinging outrigger guides are provided to assist in steering the floating vegetation to the conveyor at points where the current happens to be particularly strong. As fast as the plants pass through the rolls they are washed back into the stream by means of a centrifugal pump delivering 1,100 gpm.—the crushed material sinking to the bottom, where it soon decomposes.

Just what this continual struggle with the water hyacinth means can be better appreciated when it is known that more than 1,000 miles of rivers, streams, and bayous in the New Orleans District alone are involved; and this figure does not include hundreds of miles of feeder streams and tributaries. Canals and waterways, which have come into being within the last three quarters of a century to satisfy the demands of commerce, cross and criss-cross the Gulf States, and these, too, are susceptible to invasion by the hyacinth if it is not held in check.

That is why the *Kenney* is operated continuously day and night with three shifts of five men each. To facilitate night work, the barge is well equipped with two powerful searchlights, one on each side of the bridge, with floodlights mounted on the bridge, and with numerous lesser marine-type, protected lamps. In her drive against the rank aquatic plant, the *Kenney* moves forward at slow speed under her own power. When she is not in active service and is underway from one "battlefield" to another, she is usually towed by a tugboat chartered for the purpose. This enables her to get more quickly from point to point and also gives her more freedom of movement when actually engaged in clearing a stream for navigation. Power for all the electric motors required to operate the mechanical equipment is supplied by two 80-kw., 250-volt generators each of which is driven by a 125-hp., 4-cycle diesel engine. Water for cooling the latter is pumped from the streams; and an electric signal sounds a warning whenever engine temperature rises above and oil pressure sinks below safe limits.

In addition to destroying the water hyacinth, the *Kenney* has proved her worth in eradicating the obnoxious alligator grass and other vegetation that grows profusely in those southern waterways. These, together with cottonmouth moccasins, rattlesnakes, and other creatures that inhabit the streams, are brought on board by the conveyor. The moccasins are especially bad in the region north of Lake Pontchartrain near New Orleans, and the pads of the hyacinth are favorite sunning spots for snakes. In this connection it is worth noting that a group of biologists from Louisiana State University, who made a special trip to watch the barge at work, collected as many as 200 specimens of water snakes on that occasion. And as one of the macerator rollers swings freely, logs and other solid material not exceeding 6 inches in diameter can pass between the crushers and do not necessitate stopping the machinery.

The *Kenney* has proved so effective that a somewhat similar craft is shortly to be built and stationed at Jacksonville, Fla. This is to be used to keep the St. Johns River—one of the few American streams that flow north—and its feeders free from the troublesome water hyacinth. Several small subsidiary conveyors also are being developed in the New Orleans District office of the U. S. Corps of Engineers. Each of these is to have a capacity of 3,000 cubic yards per hour; and they are designed for service on restricted watercourses where the *Kenney* would be either too cumbersome or where her operation would be too costly.

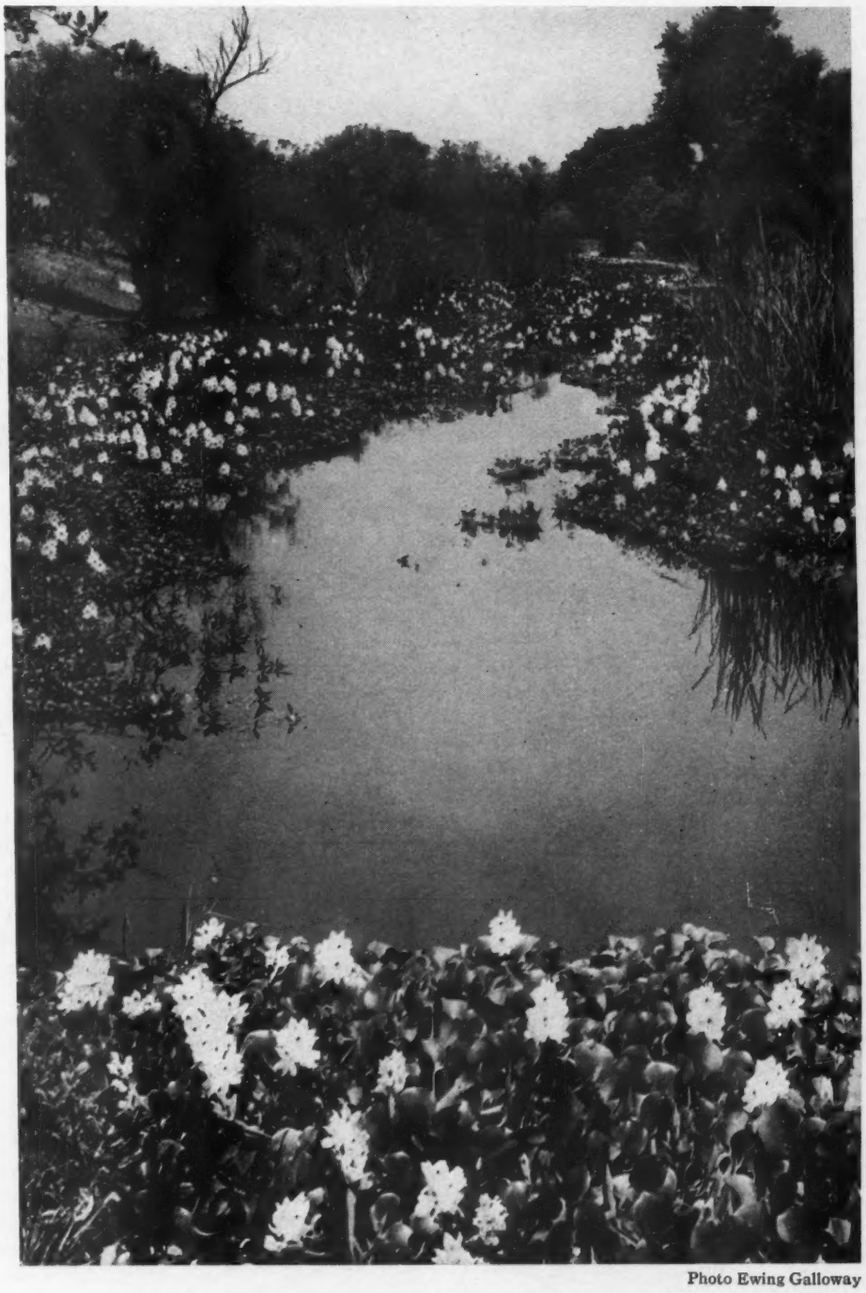


Photo Ewing Galloway

BEAUTIFUL BUT TROUBLESOME WATER HYACINTH

CONCERNING RADIUM

THE discovery and exploitation of the radium-silver ores of the Great Bear Lake area in Canada constitute what is undoubtedly one of the outstanding mineral-development enterprises of all time. The success of the venture has established Canada as the world's premier supplier of radium, but that this supremacy will long endure is by no means assured. It has not been 25 years since the radium-producing industry was centered in Colorado, yet in the meantime the turning of the wheel of fortune has shifted it first to the Belgian Congo and then back again to North America.

Impetus was originally given the radium industry in this country by two medical men, Dr. Howard A. Kelly, of Baltimore, and Dr. James Douglas of New York. Inspired by a desire to make more radium available for combating cancer, they formed the National Radium Institute, which provided the U. S. Bureau of Mines with $150,000 to finance studies to determine the best methods of mining, concentrating, and refining the carnotite ores of the West. The money was accepted on October 13, 1913, and mining claims in Montrose County, Colorado, were leased from the Crucible Steel Company. Subsequently an extraction plant was built at Denver in which a 90 per cent recovery of radium was made from ores containing 1 part in 200,000,000 parts. By 1915 considerable ore was being mined in Colorado and Utah, but most of it was being sent abroad for refinement. The price of radium was $120,000 a gram; and from 16 to 20 grams had been contracted for sale in Europe, principally in France and Germany. Only two American hospitals had as much as 500 milligrams at their disposal.

The first successful commercial refiner of radium ores in this country was the Radium Company of Colorado. An able technical staff developed extraction processes that yielded a satisfactory recovery, and the concern flourished until the finding of the vastly richer uranium-bearing deposits in the Katanga forced it to suspend operations abruptly. Anyone mentally equipped to cope with such a complex problem as the isolation of radium from the comparatively lean Colorado ores would, inevitably, have a keen academic interest in the whole series of uranium derivatives, and the refinery director, Warren F. Bleecker, was definitely one to follow doggedly the trail of scientific investigation that his post opened to him. Accordingly, while he was about it, he recovered not only the radium in the ore but also the ionium, which is the direct parent of radium in the 12-step transformation of uranium to lead. Very little was known of ionium, and Bleecker wanted to accumulate enough of it to make a thorough study possible.

As the months passed, his store of the element grew until he had more of it than had ever before been isolated. After diligently and painstakingly subjecting it to every conceivable laboratory investigation without discovering a practical use for it, Bleecker decided to send the ionium to Prof. Frederick Soddy, the eminent authority on radioactivity who was then at Oxford University in England. He boxed it securely, marked it for special handling, and sent it off. In due time he received an inquiry from the Customs officials in New York who were holding up the package, and there ensued an almost interminable exchange of correspondence. It was enlivened by the fact that Bleecker, despite his depth of mind, had a strong vein of humor in his make-up.

"What is in the box?" queried the Customs men.

"Ionium," wrote back Bleecker.

"What is ionium?" they parried.

"A radio-active element," Bleecker informed them.

"What is it good for?"

"Nothing, so far as I know."

"What is it worth?"

"I don't know. It was produced as a by-product from about $100,000 worth of uranium ore, but I don't imagine you could get a dime for it."

"Is it explosive?" (This was during the World War.)

"I don't know. That's one test I forgot to make on it."

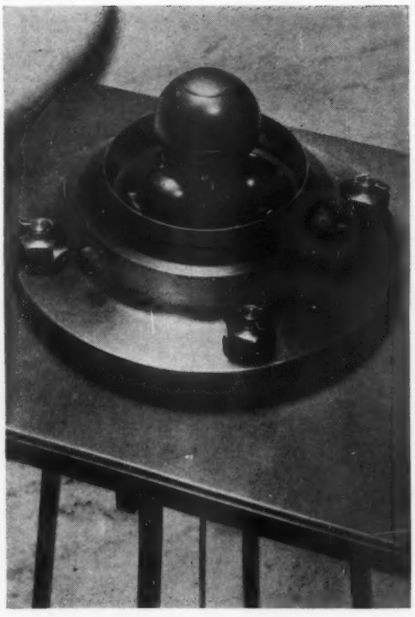
And so it went. Ultimately, the more or less bewildered officials let the shipment go through, and Professor Soddy received it many months after it had been consigned to him. Perhaps it still reposes in some laboratory cubicle at Oxford.

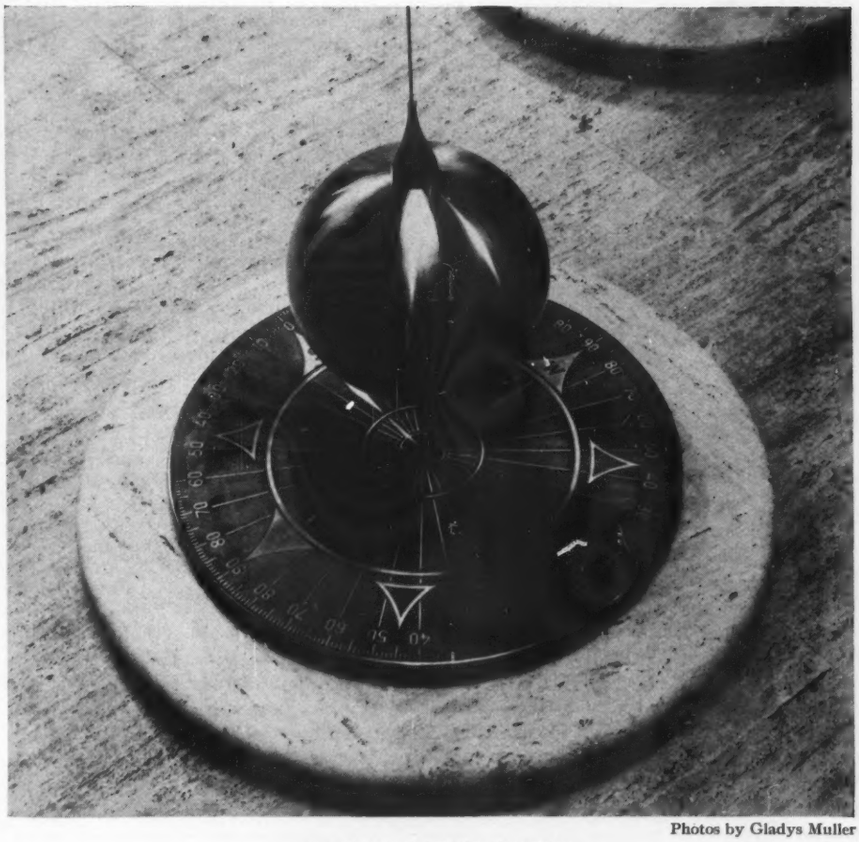
With its return to this side of the Atlantic, the radium industry is indisputably in good hands. While Eldorado Gold Mines, Limited, is in business to make a profit, it has shown by reducing the price of radium that it is also ruled by strong humanitarian impulses. In one of the few articles that he has written about his accomplishments, Gilbert LaBine, discoverer of the deposits and general manager of the operations, stated:

"From the viewpoint of commercial enterprise, we consider the present price level extremely satisfactory. At the same time, Eldorado has certain humanitarian responsibilities and it is gratifying that we have thus been able to perform this service to the medical world. We have not sought nor will we in the future seek to maintain the world price at exorbitant levels. This statement is advisable in view of published comments that the previous world monopoly in radium has been broken and that Canada will shortly have a monopoly. We, ourselves, are not in possession of sufficient facts to know whether these statements are correct. But we do know that we are now supplying a large proportion of the world demand and that, while the demand is rising, our production will also be increased in the future."

By disintegrating the atoms of some elements, physicists have recently produced electrically neutral particles called neutrons that are apparently highly effective in the treatment of cancer and more penetrating than gamma rays. There is, accordingly, a possibility that they may eventually supplant radium in the medical field; but that time seems to be some years away.

The Foucault Pendulum





Photos by Gladys Muller

PROVES EARTH TURNS

The 1,800-pound bob of the Foucault Pendulum and its dial which indicates an apparently changing direction in swing, an illusion that is caused by the earth's rotation. At the left is a view of the top of a model that shows how the pendulum is suspended from a ball on a ball-bearing mounting.

OF ALL exhibits in The Franklin Institute, Philadelphia, Pa., few attract more attention than does the Foucault Pendulum which swings majestically back and forth in its 10-second period in the main stairwell. The bird's-eye view of it from the upper floors is no less impressive than the close-up obtained by standing beside the huge ball.

It is interesting for the visitor to know that the beautiful sphere weighs almost a ton, and that the wire supporting it is 85 feet long. The top of the wire is fastened to a hard steel ball which, in turn, is balanced upon three other steel balls. A small model, showing the suspension system, is displayed near the pendulum. The bob at the bottom of the wire consists of a 23-inch-diameter metal shell filled with fine lead shot.

It was during the spring of 1851 that Jean Bernard Leon Foucault, a noted French physicist, gained world-wide attention when he hung a pendulum in the dome of the Pantheon in Paris. His original paper on the demonstration of the earth's rotation by means of that pendulum was translated for the *Journal of the Franklin Institute*, where it was published in May of 1851. The pendulum at the latter institute was donated by Mr. and Mrs. Richard L. Binder. It was on Saturday, February 15, 1934, that the Philadelphia newspapers published accounts of one of the most unusual parades ever held in that city. Led by the late Mr. Binder, eleven men, with a mounted police escort, were strung out in an 85-foot line, each holding on to the ¼-inch wire which was to support the pendulum bob. It wasn't that the wire was so heavy—it weighed only 9 pounds, but it was most important that no kinks be allowed to get into it.

In itself, the exhibit commands respect; and this is turned into something akin to awe when it is realized that the great ball, in its quiet periodic swing, proves visually that the earth rotates on its axis every day. Let us consider a merry-go-round, situated at the earth's geographic North Pole. Animals mark the points of the compass. Suspended on gimbals from the middle of the merry-go-round is a pendulum. While the merry-go-round is standing still the weight is started swinging toward a spectator standing on the side. When the merry-go-round begins to move slowly, the pendulum continues to oscillate in the direction of the onlooker, but first one animal and then another comes in line with the swing until the merry-go-round has made one complete rotation. To an observer on the merry-go-round, unconscious of anything outside and not being aware of the smooth motion of his platform, it would appear as if the pendulum itself were changing the direction of its swing.

Of course the earth is a globe, rather than a flat platform. If the pendulum were suspended directly above the North Pole, it would act exactly as it does in the case of the merry-go-round analogy, changing its apparent direction 15° each hour. On the other hand, at the equator, the plane of swing would show no change of direction. At Philadelphia, and at other points of approximately the same latitude, the plane of swing turns about 9.6° an hour, this deflection increasing the farther north the experiment is performed.

The pendulum in the institute is started in a north-south direction each day at 10 a.m. An hour later, a glance at the compass dial beneath the ball shows that the latter is no longer oscillating north and south, but about 10° from that direction. Each succeeding hour it will seem to change its course a similar extent, leading the casual observer to think that the pendulum is changing its direction of motion. Day in and day out, thousands of visitors gaze upon it and marvel at this visual proof of the fact that the earth does turn.

Sound-Absorbing Telephone Booths For Factory Use

HAVE you ever tried to carry on a telephone conversation from a desk in a busy factory? If you have, the new dwarf booths of the Burgess Battery Company should appeal to you because they are acoustic booths for service where there is a moderate amount of clatter and where space is limited. According to the manufacturer, they are designed not to shut out extraneous noises but to absorb them. This is achieved by a special lining, made of perforated metal backed by a soft sound-absorbent material, that has been used by the company with success in muffling engines, for silencing air ducts, airplane cabins, truck cabs, and the like, where quiet is desirable from the standpoint of comfort or efficiency.

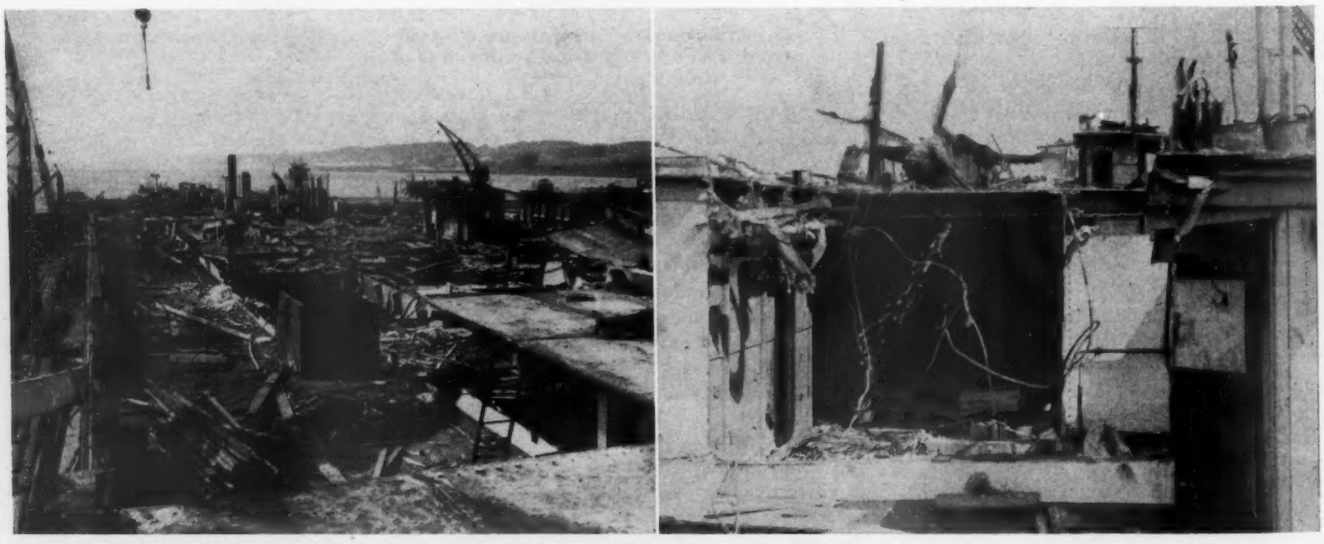
There are two models: 301, at the top of the accompanying illustration, is of the wall type with a shelf and electric light, while Model 401, at the bottom, can be set up on a desk, workbench, or any other convenient place. They are built of steel, and on the same principle as the full-length, floor-type Burgess Acousti-Booth that was introduced for industrial purposes several years ago.

Vermiculite Lends Color to World's Fair

VERMICULITE, an alteration product of mica, has several distinct characteristics which qualify it for widely diversified applications. It has been aptly called a popcornlike material because it expands many times its original size when exposed to heat. For this reason it is used, under different names, in the manufacture of insulating plaster, fireproof insulating board, acoustic plaster, composition roofing, lightweight cement, etc. By subjecting the mineral to varying degrees of heat it is possible to impart to it differing colors ranging from silver to deep copper-gold, the intensity of the color depending upon the iron content. This property of vermiculite makes it suitable also for purely decorative purposes. It is certainly a material of parts, for we are authoritatively informed that in powder form, free from all grit and sand, it is an ingredient in a lubricating paste that is sold in collapsible tubes.

In seeking a distinctive and low-cost exterior finish for the buildings of the Golden Gate International Exposition that is to be held in 1939, it was discovered that vermiculite, when applied wet to cement stucco, made it glitter under sunlight or artificial light as though studded with myriads of gems. A 100-foot wall section, erected for test purposes, verified the findings, with the result that the exposition structures are being surfaced with Zonolite, as the mineral prepared for ornamental uses is trade named. It consists of broken fragments of the raw material ground by special apparatus to preserve the coloring. It is laid on the fresh stucco walls with a darby, and any loose pieces are removed by means of a stiff wire brush when the plaster has set. It takes 4 cubic feet to cover 50 square yards; and as some 200,000 square yards of stucco are to be given this iridescent finish, approximately 150 tons of Zonolite will be required to complete the job.

It took months of experimenting by the exposition colorist, J. E. Stanton, assisted by master plasterers and under the supervision of W. P. Day, vice president and director of works, to develop this novel application of vermiculite. By day it will lend color and sparkle to the scene, and by night it will greatly intensify the lighting and cast a golden glow over the 400-acre World's Fair site and the contiguous waters of San Francisco Bay.



PICKING THE "LEVIATHAN" APART

Two views from Rosyth, Scotland, showing the havoc wreckers have made of the once majestic flagship of the United States Lines. As described in our February, 1938, issue, the former German superliner sailed under her own power last January 25 to be scrapped by Metals Industries, Ltd., and Thomas W. Ward, Ltd., which, together, purchased her for $732,000. The picture on the left shows how the great ship is being gradually torn down to the water line. At the right a workman on the upper deck is cutting some of her structural framework with a metal torch.

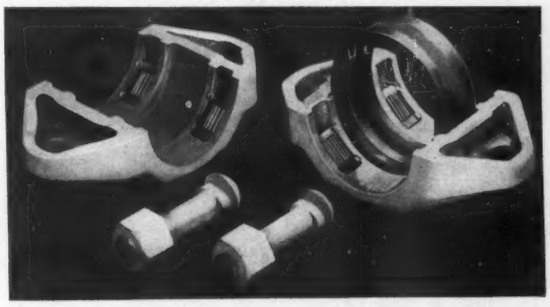
Ore Stained for Testing

LAST year, while engaged in a series of tests for the purpose of separating feldspar from quartz by the flotation process, investigators of the U. S. Bureau of Mines were struck with the thought that it would be very helpful if the results of such tests could be determined by visual means. Apparently, in the case of the average test, the color of the concentrate indicates to some extent what results have been obtained. But with two silicate minerals such as feldspar and quartz, which do not differ in color, there is no way of distinguishing between good and bad concentration. With that as a basis, the research men set out to find a method by which the feldspar could be stained and the quartz left as it is so that the purity of the flotation product or degree of separation could easily be determined by the proportion of each. This they have succeeded in doing, and the procedure developed is as follows:

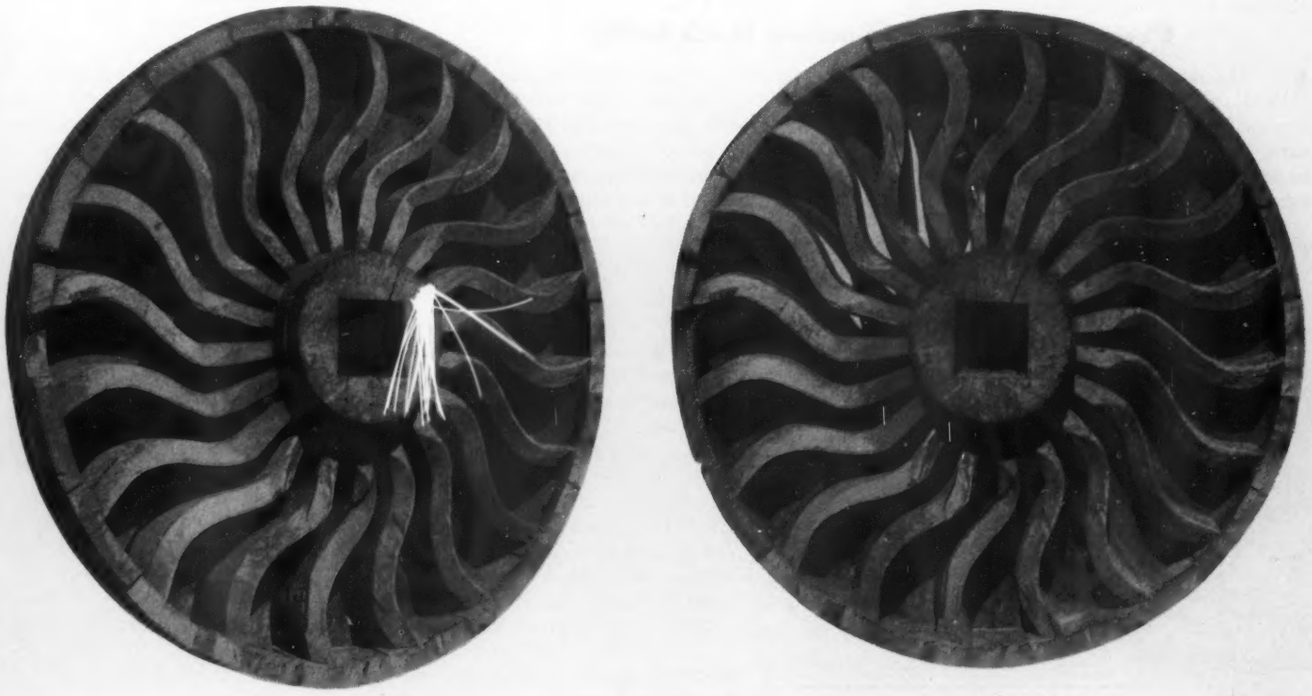
'A few grams of a representative sample of the ore are placed in a beaker and covered with a warm solution of one part hydrochloric acid and one part distilled water. After digestion for five minutes the material is washed thoroughly until free of acid. The washed material is then dried on the sand bath. When dry, the material is covered with a 2 per cent solution of safranine 0 (2 grams of dye in 30 milliliters of ethyl alcohol and 70 milliliters of distilled water) and gently warmed on a hot plate, being allowed to stand fifteen minutes or more. When the staining appears to be complete, the solution is decanted and the material thoroughly washed with distilled water. It is necessary to tumble the grains while washing to remove all traces of free staining material before drying on the sand bath. A report on these investigations—No. 3370—has been published by the U. S. Bureau of Mines.

Flexible Coupling Maintains Tight Seal

SIMPLICITY, strength, flexibility, durability, and ease of application on plain- and beveled-end pipe are claims made by the Gustin-Bacon Manufacturing Company for its Rolagrip coupling for oil, gasoline, water, air, and other lines that must be well sealed against leakage. The coupling, as the accompanying illustration shows, is of split construction, is seated on a gasket, and is held together by two bolts. There are ribbed rollers in the coupling housing that serve firmly to grip the pipe and to maintain a tight seal under normal expansion and contraction, vibration, sag, or shifting of the line.



To join two lengths of pipe, the ring gasket is slipped over one end, the two ends are brought together, the gasket is slid along until it is centered, and the two halves of the coupling are put in place and tightly bolted, work that can be done without the use of special tools. The coupling is made of copper-bearing, corrosionproof, malleable iron, and the gasket is of rubber compounded to resist oil, gasoline, natural-gas residue, water, air, etc. They are built in sizes suitable for piping ranging in inside diameter from 2 to 10 inches and to withstand a maximum temperature of 175°F. and a maximum working pressure of 1,000 pounds.



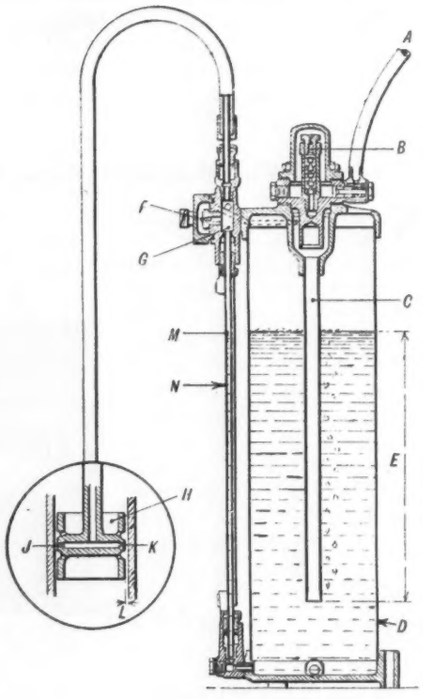
A 200-YEAR-OLD WATER WHEEL

Two pictures of the face of a wooden water turbine that was installed about 1735 nine miles north of Aguascalientes, Mexico, for driving two flour mills. It was constructed without the use of threaded rods or bolts, and was held together by the circumferential band of iron that is shown in part in the left-hand illustration. The wheel operated under a total head of 30 feet. It was placed with its face horizontal, its square shaft being in the vertical position. The water was directed against the vanes that are tangent to the circumference. The white slots where the light shows through in the right-hand picture indicate the outlet. This is believed to be one of the first turbines that were built in Mexico. The photographs were received from J. M. Elizondo of the Compania Nacional de Electricidad, S. A., at Aguascalientes.

Pneumatic Gauge for Strip Material

IN THE May, 1937, issue of this magazine is an illustration of the Solex pneumatic measuring system which has hitherto been used mainly in connection with plug and ring gauges. The application of the instrument has been lately widened by adapting it for measuring strip material such as metal, film, fabric, and the like. With it, strip 2¼ inches wide, or half the width of 4½-inch strip, can be gauged while in motion with accuracy which, it is said, does not depend on the skill of the operator.

The system, as the accompanying drawing shows, consists of two parts: of an air controller and of a gauging instrument which, by changing the type of gauge, can be used to measure diameters, bores, lengths, depths, roundness, and parallelism. Compressed air from a plant's regular source of supply is admitted to the controller through hose connection *A*, whence it flows through restriction jets *B* into tube *C*, where it expands. This tube is immersed up to a certain point in water in container *D*, which is open to the atmosphere. The pressure in tube *C* is regulated by the head of water *E*, any air in excess of that required for measuring escaping through the water seal and the opening in the top of container *D*. The air, which is thus maintained at a constant pressure, is now introduced through control jet *F* into chamber *G*, by means of which it is brought in contact with water in manometer tube *M* and



Courtesy, The Engineer

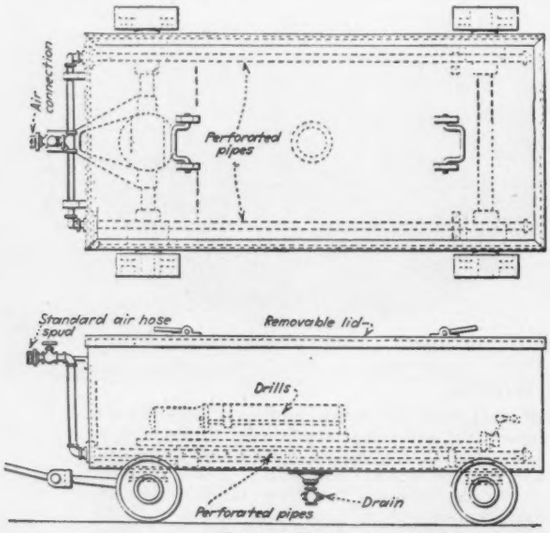
connected, by a flexible tube, with measuring gauge *H*. That shown in the drawing is on an enlarged scale and is of the plug type. But regardless of the type, the gauge is not in actual contact with the work, and the part on which measurements are based is therefore not subjected to wear. The air finally escapes through outlets *J* and *K*, the amount released being in direct proportion to the area between the gauge and the article or material being measured and, consequently, in direct proportion to the clearance at *L*. The variation is indicated at *M* and can be read on the scale *N*, which is graduated in accordance with requirements. The usual tolerance in the case of work of this kind is 0.002 inch, and this is within the capacity of the instrument.

To supplement the scale reading when gauging strip, a device can be attached to the Solex that will give audible warning whenever the limit of thickness is exceeded. This consists essentially of a mercury-filled U-tube, of a battery, and of a bell. The air in the controller regulates the flow of the mercury, which makes electrical contacts and causes the bell to ring whenever the level rises above or falls below the level corresponding to the permitted tolerance. This apparatus is not part of the equipment and is made only to order.

Pressure Tank for Cleaning Rock Drills

IN THE drill repair shop of the United Verde Branch (Jerome, Ariz.) of the Phelps Dodge Corporation is a portable tank in which rock drills removed from underground workings for overhauling are given a preliminary cleaning. The tank was designed in the shop, and is made of steel plate reinforced with angle irons; mounted on a 4-wheel truck; and provided with a tightly fitting top. Inside of the tank, as the accompanying line drawings show, are two steel brackets, which serve to hold the drill in place, and two longitudinally disposed ¾-inch perforated pipes. These are attached by flanges to a manifold on the outside and at the front end of the tank. Cleaning is done with kerosene applied under pressure.

Ordinarily, when a drill reaches the shop, it is covered with sand and dirt and must be thoroughly cleaned before it is taken apart. With the new equipment this work is considerably simplified. The procedure is as follows: Each machine, as it is received, is placed in the tank, which is half full of kerosene. After the lid is clamped down, compressed air is turned on and the kerosene maintained under pressure for approximately fifteen minutes. The drill is then removed and the tank drained and made ready for the next machine. Obviously, the purpose of the air is to force the oil in between the drill parts, thus giving the machine a good preliminary cleaning both inside and outside at the same time and with no effort.



Courtesy, Engineering and Mining Journal

New Use for Calomel

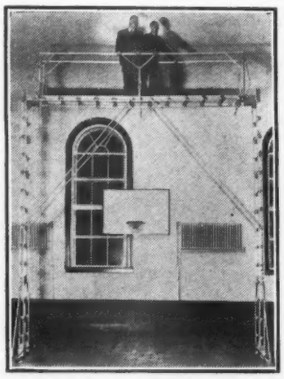
CALOMEL, a chemical that is familiar to most of us as a household remedy, has been discovered to have properties that make it of value to the metallurgist. At a meeting of the American Chemical Society, held recently in Milwaukee, Wis., it was announced by Dr. Gordon C. Pierson, of Lansdale, Pa., that the substance makes it possible to recover from liquids such elements as gold, platinum, palladium, tellurium, selenium, arsenic, and iodine.

According to this authority, mercurous chloride, as calomel is known to the chemist, has a strong affinity for these elements. When a small quantity of it in powder form is added to a mixture in which any of them are present,they will, literally, make a bee line for the calomel, attaching themselves to the tiny flakes and, together, settling to the bottom. The powder will not dissolve; and it is said that as little as one ten-millionth of a gram of any of the elements in solution can thus be recovered completely.

This method of extraction, says Doctor Pierson, has its peculiarities. Take gold and palladium, for example. In order to recover them by this process it is necessary that the acid solution used be weak, while selenium and tellurium require a 16 per cent solution of hydrochloric acid. Platinum, on the other hand, will not adhere to the calomel unless the acid solution is boiling. But, one way or the other, the results are the same. It has been suggested that this characteristic of calomel might be of assistance in ferreting out crime, because it offers a means of quickly determining cases of arsenic poisoning that it would otherwise be difficult to analyze.

Industrial Notes

Ladders that can be used as such but that are primarily designed to form scaffolds are being manufactured by the Aluminum Ladder Company. The complete assembly consists of two uprights with supporting feet to facilitate moving the scaffolding, of a cross member, of demountable railing—all of aluminum, and of spruce planks which constitute the flooring. Connection is effected by means of pins and angle braces, and height and width are adjustable. The scaffold illustrated weighs 134 pounds and can support a load of 1,000 pounds. Units built of heavier material and with a maximum carrying capacity of 2,000 pounds are available.



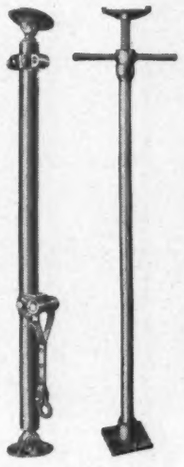
Safety Glass is the title of the latest addition to the library of motion pictures maintained for general educational purposes by the U. S. Bureau of Mines. Beginning with scenes that depict how the use of such glass in automobiles protects life and property, the 2-reel film successively shows how silica sand, the chief raw material, is obtained and prepared; how ingenious and complicated machinery converts the basic materials into glass; how plate glass is made, polished, and otherwise finished before it enters into the manufacture of safety glass; how the finished product or "sandwich" is tested, etc. The film is available in 16-mm. and 35-mm. sizes; and schools, churches, colleges, civic and business organizations can get copies by applying to the Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pa. No charge is made for the use of the film; but the exhibitor is asked to pay transportation charges.

Plans are underway for the Fifth Annual Metal Mining Convention and Exposition of the American Mining Congress, which is to be held from October 24 to 27, inclusive, at the Ambassador Hotel in Los Angeles, Calif. The exposition is under the auspices of the Western Division and will feature metal mining and milling equipment and supplies.

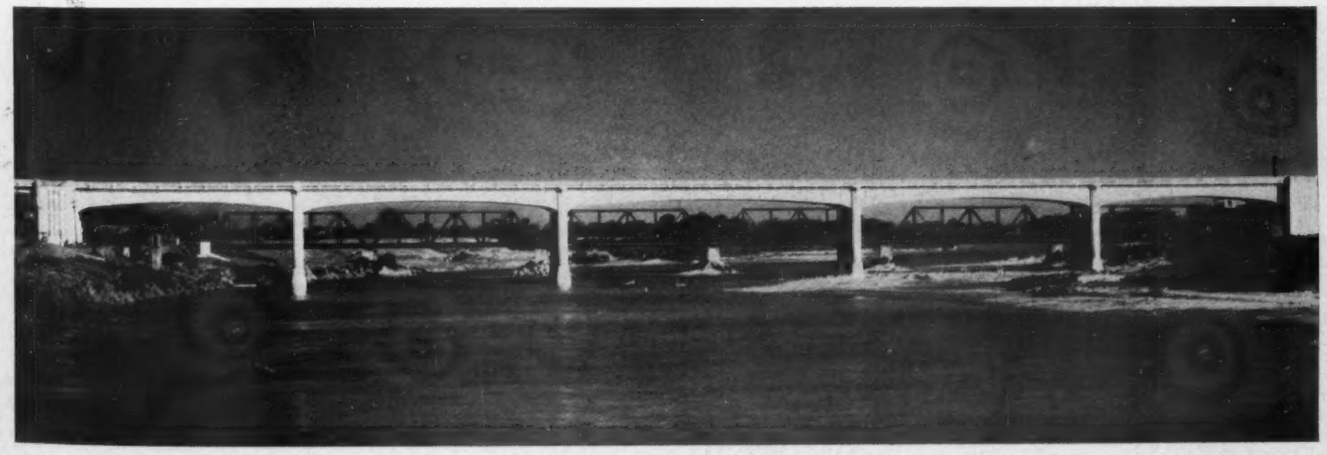
A leakproofing solution for castings that must withstand liquid or gaseous pressure in service is being offered by General Plastics, Inc., under the name of Impregnating Resin No. 278. It is forced into the pores of the casting under pressure, which may or may not be applied in a vacuum, and is baked at a temperature of 250°F. When set, the resin is claimed to be resistant to water, solvents, and mild alkalies and acids.

A loan exhibit of some 500 specimens of native rocks and rock formations is being prepared by the Michigan Department of Conservation for display in all the state's high schools. This is a worth-while movement and one that other states rich in mineral resources might copy to advantage.

For service in mines, Duff-Norton Manufacturing Company has produced two adjustable jacks of new design. The one at the right is intended to assist in the work of placing rails or cross timbers. It is operated by means of a bronze nut that engages an elevating screw, and is light enough so that one man can handle it. The left-hand one is a mine-roof jack that can be collapsed for withdrawal from a distance of 60 feet so that men do not have to enter dangerous places and run the risk of accidents. For this purpose the jack is provided with a releasing mechanism that is actuated by a lever pulled by an attached chain of suitable length. The company is prepared to supply standard units 6 feet high with a 12-inch screw adjustment and to build to order jacks ranging from 3½ to 7 feet in length.



For workers who handle such chemicals as soldering and welding fluxes, metal cleaning compounds, flushing and cutting oils, the American Solder & Flux Company has prepared a protective lotion that can be easily washed from the hands and arms.

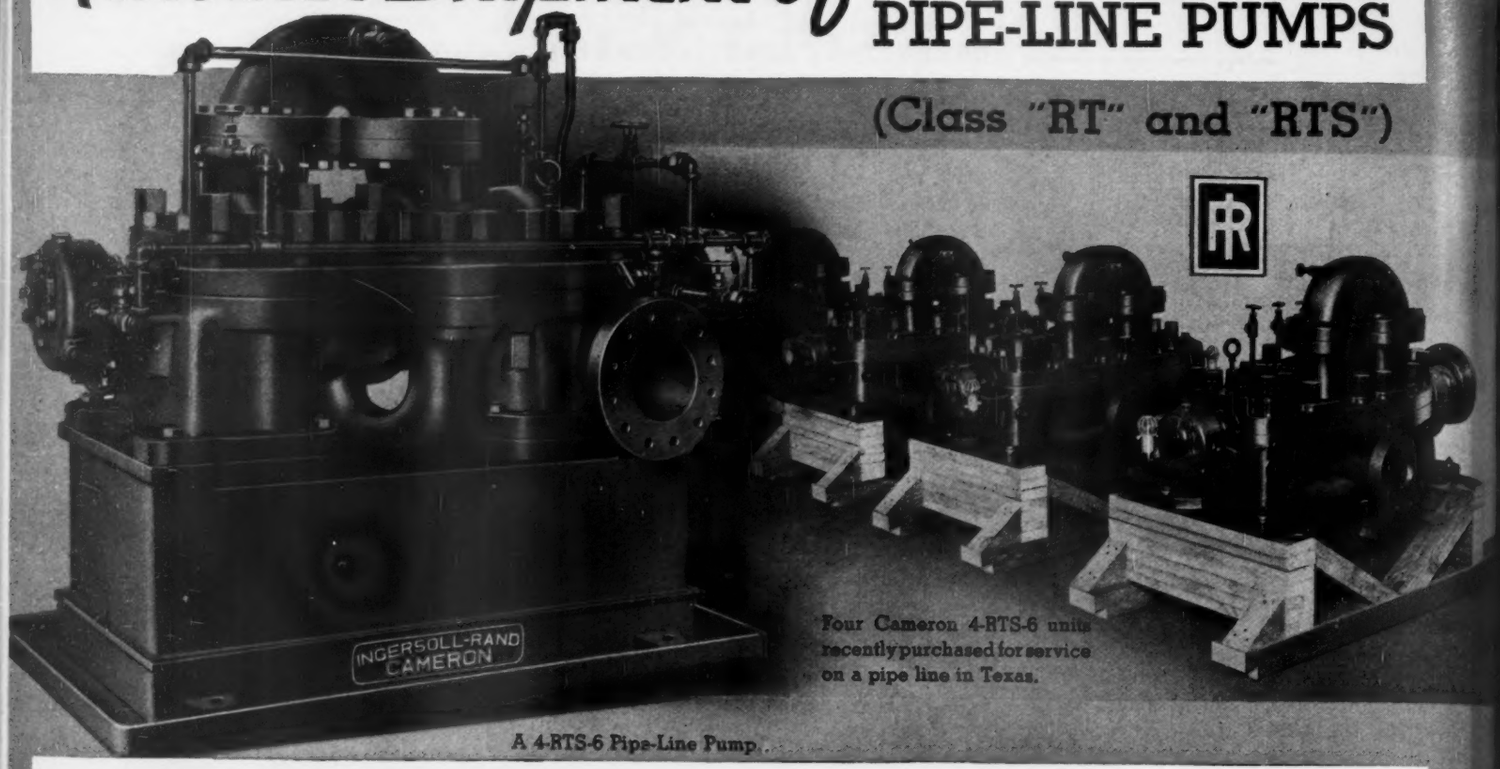


NEW BRIDGE ACROSS KANSAS RIVER

Steel men consider this new structure on U.S. Highway 75 at Topeka, Kans., to be one of our most beautiful bridges. It has a total length of 4,396 feet, consisting of 3,496 feet of concrete approaches and of the 900-foot cross-river section of steel that is shown here. Its outstanding feature is the 217-foot center span, which is claimed to be the longest in the United States for a plate girder-type bridge. The structure was built for the Kansas Highway Department and is scheduled to be opened to traffic this month. It was planned by R. A. Finney and Stuart G. Hazard, of Topeka, with Robinson & Steinman of New York serving as consultants. Contractors were the Missouri Valley Bridge & Iron Company and the Kansas City Bridge Company. The structural steel was fabricated in the shops of the Kansas City Structural Steel Company. The span was erected at a total cost of approximately $1,400,000.

Another Shipment of Up-to-the-minute PIPE-LINE PUMPS

(Class "RT" and "RTS")

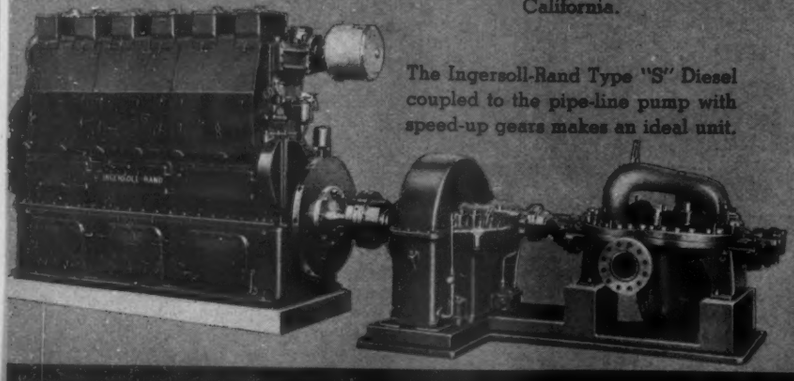


A 4-RTS-6 Pipe-Line Pump.

Four Cameron 4-RTS-6 units recently purchased for service on a pipe line in Texas.

Will Assure the User of Low Operating Costs

Twelve I-R units serve the Shell Pipe Line from Bakersfield to Caliola in California.



The Ingersoll-Rand Type "S" Diesel coupled to the pipe-line pump with speed-up gears makes an ideal unit.

HERE is the latest addition to the Ingersoll-Rand line of pipe-line pumps. Their addition permits a wide range of selection covering every service condition. Built along simple and sturdy lines they are designed to handle every liquid delivered through pipe lines at modern pipe-line pressures.

The new units represent the latest achievement of Ingersoll-Rand engineers who have been greatly aided by many years of pump building experience and the facilities of the famous I-R hydraulic laboratory. A few outstanding features are the fully protected shaft, the extra heavy bolting, the split casing, the suction pressure on both stuffing boxes which are water cooled, and the greater all-around strength of the unit.

All I-R pipe-line pumps are suitable for electric-motor, steam turbine, and diesel or gas-engine drive. For more detailed information our specialists will be glad to consult with you.

Other I-R products for the petroleum industry include gas and diesel-engine-driven compressors, many varieties of pumps, portable compressors, rock drills, impact wrenches, pneumatic tools, etc.

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